01-233853 McT.

MICOM Inc.

OPERATING and SERVICE MANUAL

model 6200

FM CALIBRATOR

©

SERIALS PREFIXED:

128---

MICOM, INC., 855 COMMERCIAL STREET, PALO ALTO, CALIFORNIA, U.S.A. 94303

CERTIFICATION

MICOM, Inc., certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory. MICOM also certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing products that prove to be defective during the warranty period. We are not liable for consequential damages.

M-1
MEASUREMENT
...OLOGY

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855 Commercial Street, Palo Alto, California, U.S.A.

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MICOM MODEL 6200 FM CALIBRATOR

SPECIFICATIONS

Center Frequencies

432kHz, 216kHz, 108kHz, 54kHz, 27kHz, 13.5kHz, 6.75kHz, 3.375kHz, and 1.6875kHz with ±40% full-scale deviation; and 900kHz, 450kHz, 225kHz, 112.5kHz, 56.25kHz, 28.125kHz, 14.062kHz, 7.03kHz, and 3.516kHz with ±30% FULL-SCALE DEVIATION.

Crystal Oscillator

The center frequency and all static deviation frequencies are derived from a crystal oscillator with a ±0.01% accuracy. A counter chain counts down to the desired frequency. Static deviation frequencies are ±100%, ±75%, ±50%, and ±25% of full-scale deviation. The optional modulator is also running at these frequencies and may be checked or zero-beat by switching to MOD CHECK mode.

Modulator (In Option -01 instruments)

The modulator provides signals for dynamic signal testing. The modulating signal is either an internal square wave or an external voltage.

Internal Square Wave Modulation

Approximately ±full-scale deviation at 100Hz.

External Modulation

Separate input, 10K resistance. Sensitivity as selected by DCV FULL SCALE control.

Carrier Output

Square wave adjustable up to 6 volts peak-to-peak, open circuit. Output impedance selected by internal jumper, 75 or 50 ohms. Less than 5% dissymmetry above 600kHz, less than 3% between 600 and 250kHz, and less than 1% below 250kHz.

Full-Scale DC Voltage

Front panel selected; ±1.0V, ±1.414V, ±2.0V. Accuracy ±0.1% of peak-to-peak output. The deviation control from this selects the appropriate output voltage.

DC Output

Output impedance less than 10 milliohms. Will drive 50 ohms at ±2.0 volts. Not harmed by a short-circuit to ground.

DC Input Termination

Front panel selected; 75 ohms, 600 ohms, 1000 ohms, 10K, or 10 megohms. Not harmed by ±30 volt input.

Voltage and Frequency Comparison

The zero-center meter indicates the difference between the measured frequency or voltage and the desired one. Full-scale sensitivities of ±1%, ±3%, ±10%, and ±30% of full deviation are provided. In addition, the dc voltage from the reproduce channel can be displayed on a ±100% scale.

Audible Null Indicator

A small loudspeaker is provided, which will give an audible indication of either voltage or frequency error. The click rate is an analog of the meter deflection. The volume may be regulated or turned off. A front panel earphone jack is also provided.

General

Mounting: Bench, convertible to rack mount.
Ambient Temperature: 0 to +50°C.
Power Requirements: 115V ±10% 48-420Hz, 35 watts or 230V ±10%.
Front Panel Dimensions: 5.25" x 19" wide.
Cabinet Dimensions: 5.25" x 19" x 13" overall.
Net Weight: 22 lbs. Shipping Weight: 26 lbs.

Specifications subject to change without notice.

Made in U.S.A.

December 1968

SECTION I

GENERAL INFORMATION

1-1 DESCRIPTION

The Model 6200 FM Calibrator permits rapid testing and adjustment of FM modulators and demodulators. Although designed for use with instrumentation tape recorders, the Model 6200 can be used with other FM modulators and demodulators that operate at IRIG standard tape recorder frequencies up to 900 kHz.

The Model 6200 supplies a signal to the modulator or demodulator under test, compares the response to an internal standard and automatically displays the difference as "percent error". A front panel speaker and earphone jack provide audio error indication. The audio rate indicates amount of error.

Front panel selection of internal calibration circuits permits a rapid "self check" of instrument performance. Front panel adjustments enable simple calibration of critical circuits.

On Option -01 instruments, internal square wave modulation allows dynamic evaluation of demodulator performance on an oscilloscope. An external signal input permits external modulation of the demodulator test signal.

SECTION II

INSTALLATION

2-1 INSPECTION

This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of scratches or defects, and in perfect electrical order upon receipt. To confirm this, inspect the instrument for physical damage received in transit. Also, test the electrical performance of the instrument (see Section V). If there is damage or deficiency, see the warranty on the inside of the front cover.

2-2 CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. Refer to Section V, Performance Checks and Calibration. The instrument is insured for safe delivery. If it is damaged in any way, or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

2-3 POWER REQUIREMENTS

The Model 6200 operates from either 115 or 230V ac, 50-400 Hz. To convert from 115 to 230 volt operation, change the position of the slide switch (located on rear panel) so that the designation exposed on the switch matches the nominal power line voltage. Use either $\frac{1}{2}$ ampere, slow-blow fuse for 115-volt operation, or a $\frac{1}{4}$ ampere slow-blow fuse for 230-volt operation.

2-4 THREE CONDUCTOR POWER CABLE

To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All MICOM instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong adapter to ground.

2-5 INSTALLATION

The Model 6200 is fully transistorized, and therefore requires no special cooling. However, the instruments should not be operated where the ambient temperature exceeds 55°C (130°F).

2-6 RACK/BENCH INSTALLATION

The Model 6200 is shipped as a bench type instrument, with rubber feet. To mount the instrument in a standard 19" relay rack, remove the side castings. Two 10-32 screws in each handle and one side mounting screw to the rear attach each casting to the instrument. Use the screws in the handles to fasten the instrument in a rack.

2-7 REPACKAGING FOR SHIPMENT

The following is a general guide for repackaging for shipment. If you have any questions, contact the factory.

a. Place instrument in original container if available. If original container is not used:

b. Wrap instrument in heavy paper or plastic before placing in an inner container.

c. Use plenty of packing material around all sides of the instrument, and protect the front panel with cardboard strips.

d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

e. Mark shipping container with "Delicate Instrument", "Fragile", etc.

NOTE

If the instrument is to be shipped to MICOM for service or for repair, attach a tag to the instrument identifying the owner and indicate the necessary service or repair. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model and serial number.

Ship to: Service Department
MICOM, INCORPORATED
855 Commercial Street
Palo Alto, California 94303

SECTION III

OPERATING INSTRUCTIONS

3-1 INTRODUCTION

The Model 6200 FM Calibrator can be used to test and adjust modulators and demodulators separately or when connected o. a complete recording system.

3-2 GENERAL OPERATING INFORMATION

The INTERNAL CAL pushbuttons provide a self-check of instrument performance. Front panel adjustments permit operator calibration of critical circuits for zero error meter reading.

The DCV FULL SCALE switch is set to correspond to the dc value required for full scale deviation of device under test and determines full scale modulation sensitivity for external modulation (option -01 instruments). CARRIER LEVEL sets amplitude of carrier signal to demodulator being tested. TERMINATION switch ensures proper impedance load for output of modulator under test.

The FULL TEST pushbuttons select type of measurement to be made. Modulator or demodulator tests are made by depressing the appropriate black button. MOD-DEMOD button is for system tests. CARRIER ONLY pushbuttons select external modulating signal applied at EXT SIG IN terminal or 100Hz internal square wave modulation for dynamic testing of demodulator performance (option -01 instruments only).

The % DEVIATION switch selects the measurement to be made. Zero position tests device with no modulation. ±100%FS positions test at full scale deviation. Remaining switch positions test linearity by measuring deviation accuracy at ±25, ±50, and ±75% of full scale deviation.

The METER RANGE switch selects maximum error displayed on meter in percent of full scale output or peak deviation. The ±100% DC READING position provides meter display of the dc output of the demodulator under test.

The CENTER FREQUENCY switch selects the center frequency of the test carrier. Table 3-1 shows frequency setting for appropriate tape speed used. FREQUENCY GROUP switch selects frequency band available. LOW position corresponds to black numbers on CENTER FREQUENCY switch; HIGH position corresponds to red numbers.

Audio error indication provided by the front panel speaker is controlled by the VOLUME control, and the RATE control, during DEMOD and MOD-DEMOD operation, provides a desired "no error" click rate. Use of PHONE jack automatically mutes the speaker.

3-3 PANEL FEATURES

Front and rear panel features are described in Figure 3-1. Description numbers correspond to numbers on illustration.

3-4 OPERATING PROCEDURES

An instrument self-check is described in Figure 3-2. Step-by-step operating procedures are described in Figures 3-3 through 3-5. Procedure steps are numbered to correspond to related controls in the illustration.

TABLE 3-1

CENTER FREQUENCY VERSUS TAPE SPEED

Tape Speed (ips)			
Low Band	Intermediate Band	Wide Band Group I	Carrier Center Frequency kHz
1-7/8			1.688
3-3/4	1-7/8		3.375
7-1/2	3-3/4		6.750
15	7-1/2	3-3/4	13.500
30	15	7-1/2	27.000
60	30	15	54.000
	60	30	108.000
	120	60	216.000
		120	432.000

Wide Band Group II	Carrier Center Frequency kHz
3-3/4	28.125
7-1/2	56.250
15	112.500
30	225.000
60	450.000
120	900.000

3-5 GENERAL OPERATING AND MEASUREMENT CONSIDERATIONS

See Table 3-1, IRIG Recommendations for Center Frequency versus Tape Speed. Check the Operating Instructions for your tape system to determine proper center frequencies for your system.

INITIAL TURN-ON

a. Set rear panel slide switch to correct line voltage. Exposed number indicates line voltage to be used.

b. Check line fuse for correct rating. For 115V ac operation, use 0.5 Amp, slow-blow fuse; for 230V ac use 0.25 Amp, slow-blow.

c. Connect power cord to line voltage.

d. Set METER RANGE switch to ±100% DC READING position.

e. Push POWER button. Lamp lights to indicate that primary voltage is applied to instrument.

3-6 CARRIER LEVELS BELOW 100mV

Optimum settability of low level carriers is attained by placing an attenuator at the CARRIER TO DEMOD output terminal and adjusting the CARRIER LEVEL control for the desired carrier level to the demodulator under test.

3-7 75 OHM OPERATION

For maximum accuracy, take the voltage drop in the cables into account. Put a "T" connector at the demodulator load (A-D converter, etc.) and run another cable back to the 6200's DC FROM DEMOD jack. Set the TERMINATION switch to the 10M position.

3-8 STANDBY OPERATION

The METER RANGE switch should be set to the ±100% DC READING position whenever the FM Calibrator is on but not connected in a measurement setup. With no signals applied to the FM Calibrator, 100% error indications can result, pegging the meter.

3-9 AUDIO ERROR INDICATOR

The Model 6200 is equipped with an audio error indication circuit. The error displayed on the meter is also indicated aurally with the audio rate (frequency) indicating the amount of error. Use of the front panel headphone jack automatically mutes the speaker. Any monaural headphones may be used.

NOTE: On modulator testing, there are false zero-beats at some frequencies far removed from the normal error range. The meter will be off scale and should be used to bring the error below 30%.

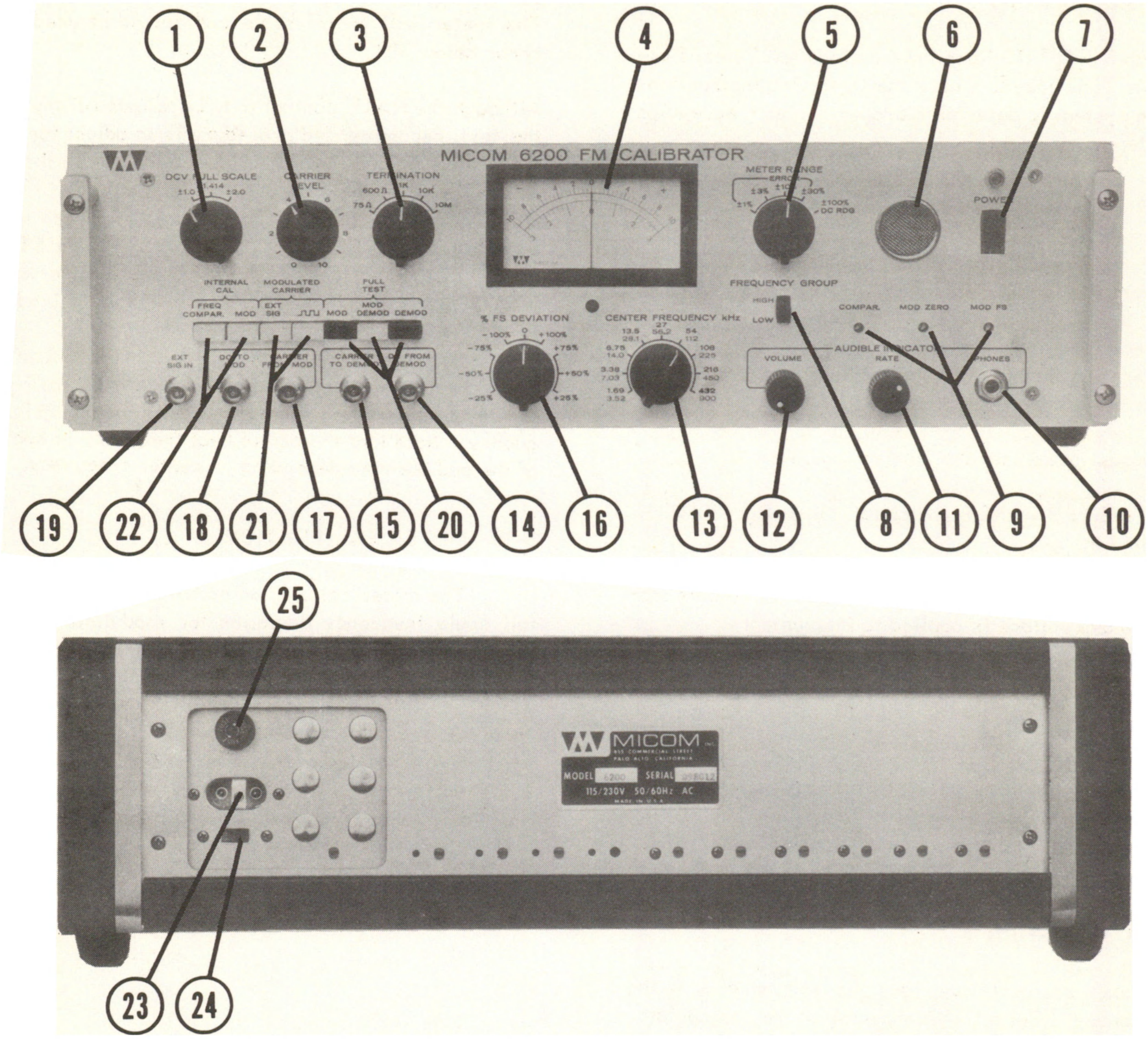
Although the RATE control may be adjusted at any time during the test, recommended procedure is to adjust for the desired "Zero-Error" rate with the FM Calibrator in the DEMOD or MOD-DEMOD mode:

Set METER RANGE to ±100% DC RDG; set % FS DEVIATION to 0 or disconnect the demodulator output or otherwise produce a zero meter reading. Adjust RATE for desired click rate.

The rate control does not function in the other modes. In these modes, the rate is derived from the beat note between the modulator being tested and the internal reference frequency. Note that the actual beat frequency is some multiple of the audible rate depending on center frequency.

3-10 METER CALIBRATION

The meter calibration on the Model 6200 is in terms of full scale frequency deviation for modulator testing and full scale dc output for demodulator or modulator/demodulator testing. For example, at 108kHz in the LOW BAND mode, which has 40% full scale deviation, a 1% meter reading is 1% of 40%, or 0.4%, of center frequency. Similarly, for 1.414 volts dc full scale, a 1% meter reading is an error of 1% of 1.414 volts, or 14.14 millivolts. Thus, modulator and demodulator linearity measurements may be compared directly.



1. DCV FULL SCALE. Selects dc voltage required for full scale deviation by modulator under test and adjusts the gain to fit the dc voltage produced by the demodulator.

2. CARRIER LEVEL. Sets amplitude of test carrier to demodulator under test. Clockwise rotation increases carrier level.

3. TERMINATION. Selects the resistor required to properly terminate demodulator under test.

4. Meter indicates difference between test response and internal standard as error in percent of full scale output or peak deviation. With METER RANGE switch set to ±100% DC READING position, meter displays dc output of demodulator under test.

5. METER RANGE selects meter sensitivity. ±1%, ±3%, ±10%, and ±30% positions show error. ±100% DC READING position connects meter to display dc response of demodulator under test, and is also used for standby operation.

6. SPEAKER. Provides audio error indication. Audio rate indicates amount of error. Volume and rate can be set by front panel controls.

FIGURE 3-I. FRONT AND REAR PANEL CONTROLS

7. POWER. Turns instrument on and off. Lamp lights to indicate that primary power is applied to instrument.

8. FREQUENCY GROUP. Selects test carrier frequency range available. LOW position corresponds to black numbers on CENTER FREQUENCY switch; HIGH position corresponds to red numbers on CENTER FREQUENCY switch. Switch automatically provides correct deviation (±40% of center frequency on LOW; ±30% of center frequency on HIGH).

9. COMPAR/MOD ZERO/MOD (screwdriver adjustments). Permits operator calibration of critical circuits. COMPAR adjusts frequency comparator for zero error. MOD FS adjusts modulator for zero error at ± full scale deviations. MOD ZERO adjusts modulator for zero error at zero modulation. (MOD ZERO & FS for option -01 instruments only).

10. PHONES. Permits use of headphones in place of front panel speaker. Use of phone jack automatically mutes speaker.

11. RATE. Adjusts click rate of audio output during DEMOD and MOD-DEMOD tests. Clockwise rotation increases rate.

12. VOLUME. Adjusts volume of audio output. Clockwise rotation increases volume.

13. CENTER FREQUENCY. Selects test carrier center frequency. Frequency used is usually determined by tape speed used (see Table 3-1). Black numbers correspond to lower IRIG frequencies; red numbers correspond to upper IRIG frequencies. The black or red numbers (frequency group) are selected by the FREQUENCY GROUP switch.

14. DC FROM DEMOD. Input terminal for dc output of demodulator under test.

15. CARRIER TO DEMOD. Output terminal for test signal to demodulator under test.

16. % FS DEVIATION. Selects deviation at which measurement is made. Zero position measures error of device under test with no modulation applied. ±25, 50, 75% measure error of device with 25, 50 and 75% of modulating signal applied. ±100% positions measure error of device with 100% of modulating signal applied. Full deviation is 40% of CENTER FREQUENCY for LOW frequency group and 30% of CENTER FREQUENCY for HIGH frequency group.

17. CARRIER FROM MOD. Input terminal for carrier output of modulator under test.

18. DC TO MOD. Output terminal for dc test signal to modulator under test.

19. EXT SIG IN. Input terminal for external modulator signal to the calibrator's internal modulator. Sensitivity also set by DCV FULL SCALE. (Option -01 instruments only.)

20. FULL TEST (pushbuttons). Select type of measurement to be made. Depressing MOD button supplies dc test signal to modulator under test and measures response at CARRIER FROM MOD terminal only. Depressing MOD-DEMOD button supplies dc test signal to modulator of system under test* and measures dc output of system demodulator. Note that the tape system must be playing, in this mode. Depressing DEMOD button supplies test carrier to demodulator under test and measures response at DC FROM DEMOD terminal.

*Actually, the dc test signal is always present, and the test carrier signal is also present except when the MOD-DEMOD button is depressed.

21. MODULATED CARRIER pushbuttons (for Option -01 instruments only). Used for testing dynamic response of demodulators. Depressing EXT SIG button modulates test carrier signal with signal at EXT SIG IN terminal. Depressing square wave (⊓⊔) button modulates test carrier signal with an internal 100 Hz squarewave.

22. INTERNAL CAL pushbuttons. Permit rapid evaluation and adjustment of critical internal circuits. Depressing FREQ COMPAR button checks error of frequency comparator. Depressing the white MOD button (Option -01 instruments only) checks error of modulator (at all deviations on the % DEVIATION switch). The CENTER FREQUENCY must be set for 900 kHz or 432 kHz for either check.

23. AC POWER CONNECTOR provides input connections for ac power.

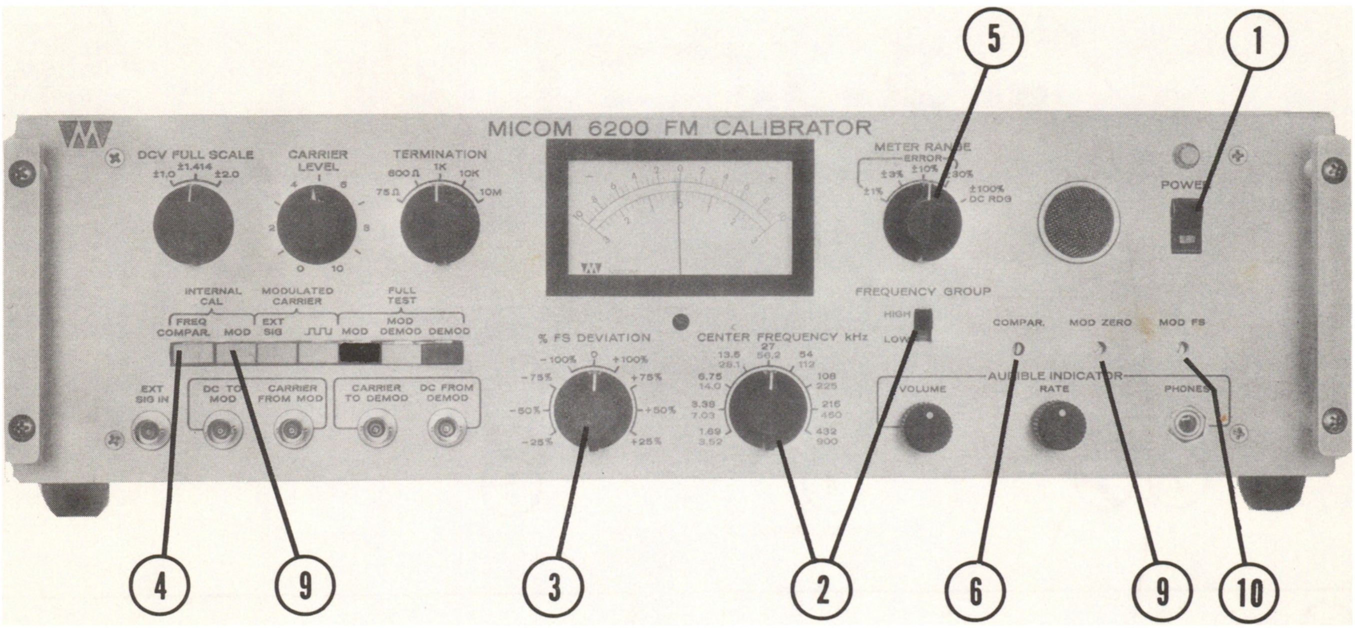
24. LINE VOLTAGE (115V/230V) switch sets instrument to operate from 115V or 230V ac power line. Note that the fuse must be changed when the voltage is changed: 1/2A for 115V, 1/4A for 230V.

25. FUSE provides protection for line and instrument circuits.

FIGURE 3-1. FRONT AND REAR PANEL CONTROLS.

NOTES

INSTRUMENT SELF CHECK



1. Turn POWER on and allow one minute warm-up.

2. Set FREQUENCY GROUP to either HIGH or LOW, as required for testing, and CENTER FREQUENCY to 432 kHz/900 kHz.

3. Set % DEVIATION to 0.

4. Depress INTERNAL CAL/FREQ COMPAR button.

5. Set METER RANGE to ±1%. The meter should show 0 ±.05%.

6. Adjust front panel COMPAR adjust for 0 ± .05% meter reading, if required.

7. Set % DEVIATION switch to +100% and check for ±.05% error.

8. Set % DEVIATION switch to -100% and check for ±.05% error.

STEPS 9-12 ARE FOR OPTION -01 INSTRUMENTS ONLY . . . . . .

9. Depress INTERNAL CAL/MOD button and with 0% deviation set, adjust front panel MOD ZERO for 0 ±.05% meter reading.

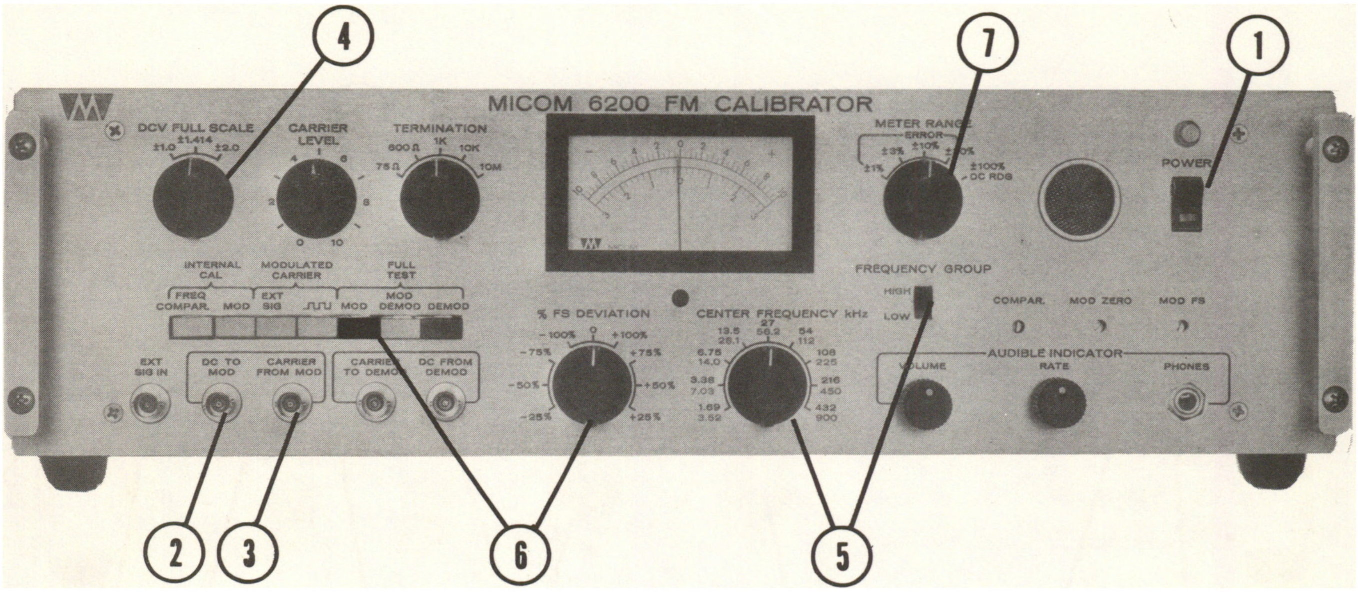
10. Set % DEVIATION to +100% and adjust front panel MOD FS for approximately zero error meter reading if required.

11. Set % DEVIATION to -FS and observe the meter reading.

12. Set % DEVIATION back to +FS and repeat steps 10 and 11 until the readings obtained at +100% and -100% are about equal.

FIGURE 3-2 INSTRUMENT SELF-CHECK.

MODULATOR TESTING



1. Allow warm-up.

2. Connect DC TO MOD terminal to input of modulator under test.

3. Connect output of modulator under test to CARRIER FROM MOD terminal.

4. Set DCV FULL SCALE to desired position.

5. Set FREQUENCY GROUP and CENTER FREQUENCY to desired position.

6. Depress the black MOD button and set % DEVIATION to desired position.

7. Set the METER RANGE switch to the desired error sensitivity and adjust modulator under test for minimum error. If desired, the error at each deviation may be observed, and a compromise adjustment made.

8. When the error is very small, the rate of clicks from the loudspeaker and of "kicks" of the meter needle will be a sensitive error indicator. That is, a very low rate means a very low error. Note that at some very large errors, where the meter is off scale on the ±30% range, there can be a false zero beat. (The quality of the beat note is different, also.)

9. Many modulators have an adjustment for nulling the input circuit so that no dc is drawn from the signal source driving the modulator. (Consult the instructions for your machine.) This adjustment may be made in two ways:

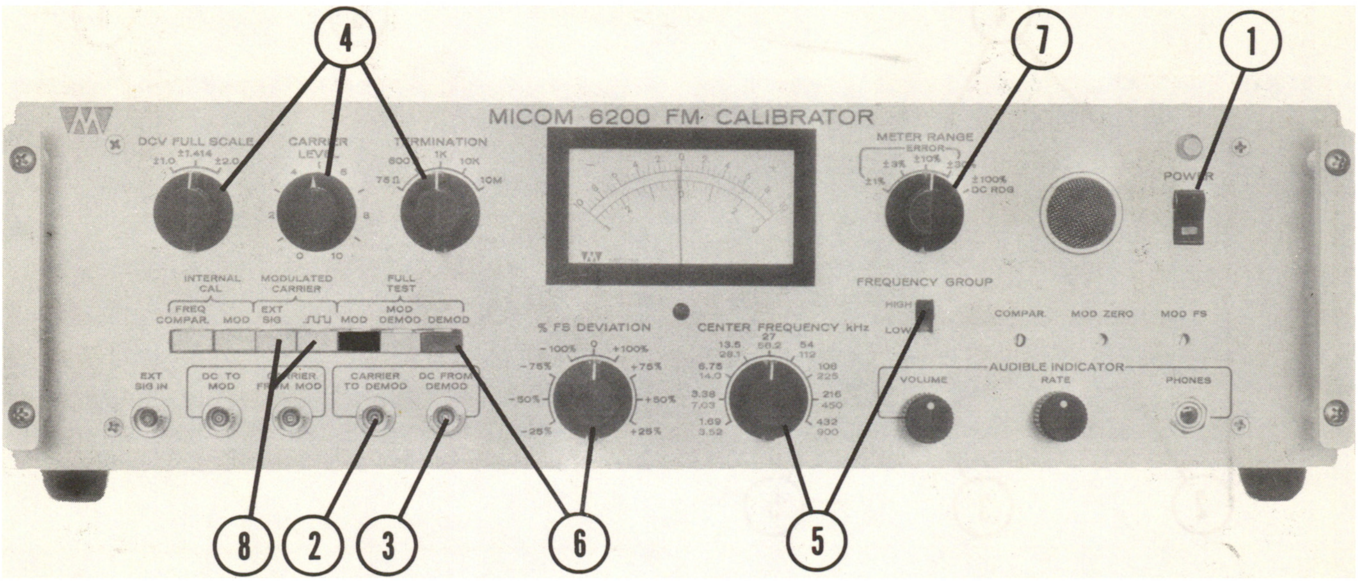
   (a) With the modulator operating at center frequency, set the % FS DEVIATION switch to "0" and the METER RANGE switch to 1%. Alternately connect and disconnect the DC TO MOD cable. Adjust modulator input null to obtain minimum shift in meter reading.

Another procedure is as follows:

   (b) Move the input cable to the modulator from the DC TO MOD jack to the DC FROM DEMOD jack for this measurement. Depress the DEMOD button. Set % FS DEVIATION to "0", TERMINATION to 10K or 10M and METER RANGE TO ±1%. Adjust modulator input null until meter reads zero.

FIGURE 3-3 MODULATOR TESTING.

DEMODULATOR TESTING



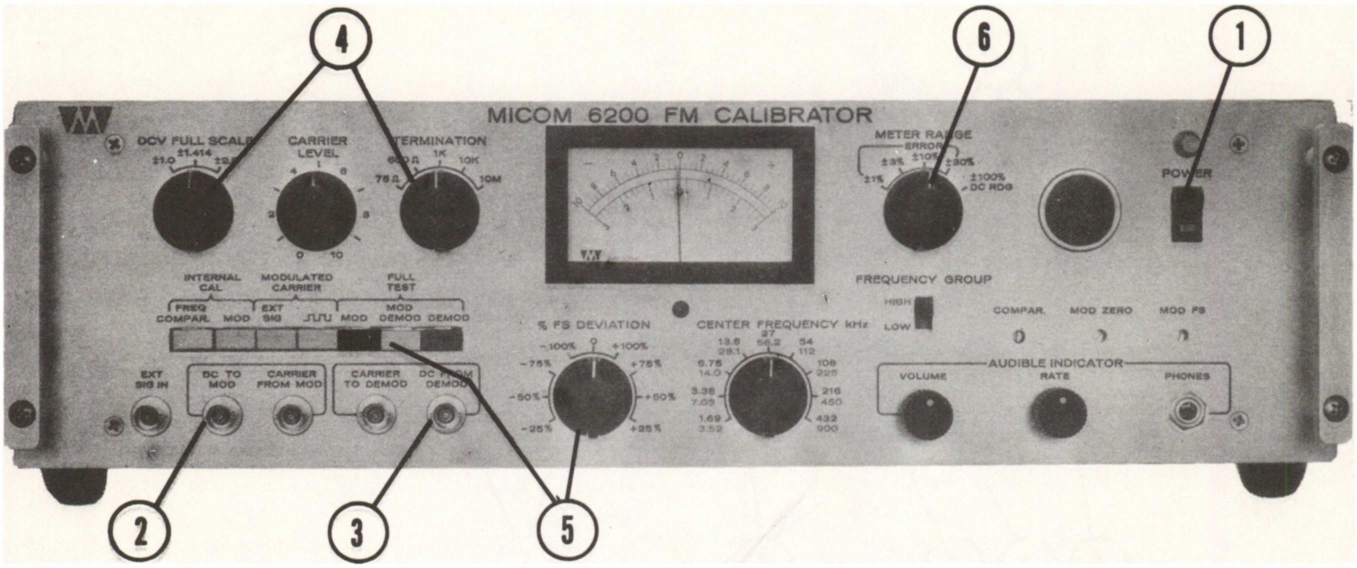
1. Allow warm-up.
2. Connect CARRIER TO DEMOD terminal to input of demodulator under test.
3. Connect output of demodulator under test to DC FROM DEMOD terminal.
4. Set DCV FULL SCALE, CARRIER LEVEL and TERMINATION to desired positions.
5. Set FREQUENCY GROUP and CENTER FREQUENCY to desired position.
6. Depress DEMOD button and set % DEVIATION to desired position.
7. Set METER RANGE switch to desired error sensitivity and adjust modulator under test for minimum error. If desired, the error at each deviation may be observed and a compromise adjustment made. The dc output of the demodulator can also be directly displayed by setting the METER RANGE switch to the ±100% DC READING position.

(Option -01 instruments only).

8. If using internal square wave modulation, depress square wave (⊓⊔) button and observe response on an oscilloscope. If using external modulation, connect modulating signal to EXT SIG IN and depress EXT SIG button. DCV FULL SCALE switch determines modulation sensitivity

FIGURE 3-4 DEMODULATOR TESTING.

SYSTEM TESTING



1. Allow warm-up.	5. Depress MOD-DEMOD button and set % DEVIATION to desired position.
2. Connect DC TO MOD terminal to input of systems modulator under test.	6. Set the METER RANGE switch to desired error sensitivity and adjust system as required. The dc output of the system's demodulator under test can also be displayed directly by setting the METER RANGE switch to the ±100% DC READING position.
3. Connect output of systems demodulator under test to DC FROM DEMOD terminal. Connect jumper between systems modulator and demodulator (or record on tape).	
4. Set DCV FULL SCALE and TERMINATION to desired position.	

FIGURE 3-5 MODULATOR-DEMODULATOR (SYSTEM) TESTING.

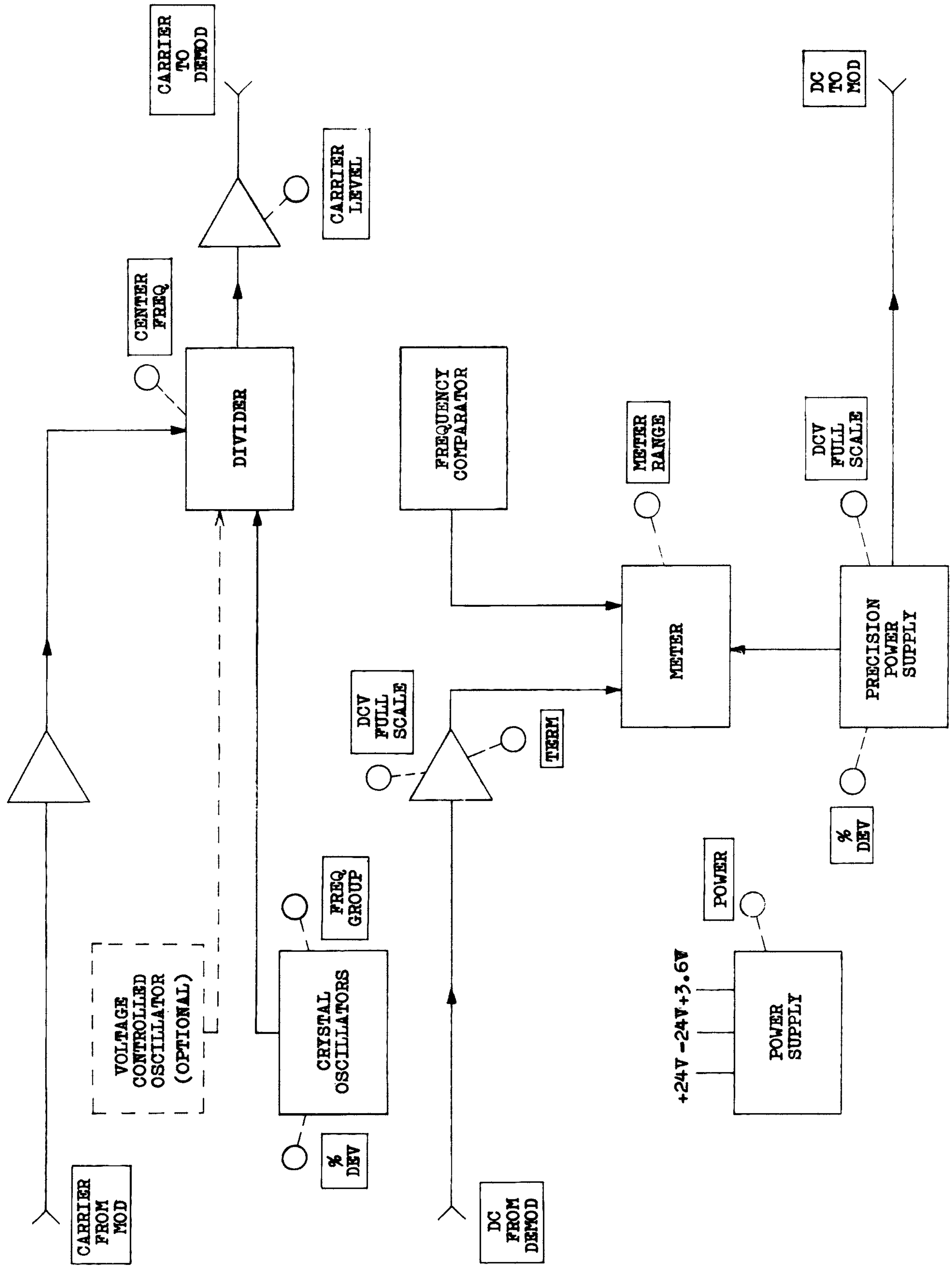


FIGURE 4-1 SIMPLIFIED BLOCK DIAGRAM.

SECTION IV

THEORY

4-1 INTRODUCTION

The Model 6200 FM Calibrator consists of three major sections: the precision dc supply, crystal oscillator, and frequency comparator. On Option 01 instruments, a voltage controlled oscillator (VCO) is furnished. Modulated carriers are derived from this unit. Figure 4-1 is a simplified block diagram of the Model 6200. A detailed circuit analysis is given in Paragraphs 4-6 through 4-16.

4-2 PRECISION DC SUPPLY

The precision dc supply, incorporating a temperature compensated Zener diode and precision voltage divider, provides the internal dc standards and modulator test signal. The supply has two outputs applied to three circuits: (1) one side of the meter as the reference, (2) the voltage-controlled oscillator as the control voltage, and (3) the DC TO MOD terminal as the modulator test signal.

During demodulator and modulator-demodulator tests, the % DEVIATION switch selects the voltage that is applied to the meter. The DC FROM DEMOD signal is amplified and applied to the other side of the meter. Any difference between the two voltages is indicated as error on the meter.

This supply output is also applied to the VCO during all static tests.

The DCV FULL SCALE switch selects the proper portion of that voltage and applies it to the DC TO MOD terminal as the dc test signal.

When the METER RANGE switch is in the ±100% DC READING position, the reference side of the meter is grounded and the meter monitors the actual dc output of the demodulator under test.

4-3 CRYSTAL OSCILLATOR SECTION

The crystal oscillator generates the internal reference signal for modulator tests and the test carrier signal for demodulator tests. The % DEVIATION and FREQUENCY GROUP switches select one of eighteen available crystals.

For demodulator tests the CENTER FREQUENCY switch, connected to the divider, selects the frequency division required to produce the correct test carrier frequency.

For modulator tests, the crystal oscillator signal is applied to one of the two divider circuits in the divider section as the reference. The signal from the modulator under test is applied to the second divider circuit. After setting the CENTER FREQUENCY switch, both signals are divided and applied to the frequency comparator.

4-4 VOLTAGE-CONTROLLED OSCILLATOR (INTERNAL MODULATOR)

The voltage-controlled oscillator supplies the signal to the divider during the modulator self-check, internal square wave and external modulation operations, rather than the crystal oscillator. The divided signal appears as test carrier signal.

4-5 FREQUENCY COMPARATOR

The frequency comparator compares two outputs of the two divider circuits. Its output is a voltage equivalent to the frequency difference between two signals. This volt-output is applied to the meter and provides a deflection proportional to the frequency error.

During the frequency comparator self-check (INT. CAL.) the crystal oscillator signal is applied to both divider circuits and thus to both frequency comparator inputs.

4-6 PRECISION DC SUPPLY (CARD 6237)

The precision dc supply consists of three major functions: (1) a precision voltage source, (2) a voltage divider and voltage follower, and (3) a voltage divider and voltage follower/booster.

The precision voltage source, consisting of a temperature compensated Zener diode, CR3, and a precision voltage divider R1 through R6, supplies a precise dc voltage to one input of operational amplifier, A1. The % DEVIATION switch S4A-D selects polarity and value of the dc signal. The VOLTAGE SOURCE CALIBRATE pot (VSC), R1, is adjusted for 8.000V at Pin 5 of the 6237 Card. 100% deviation is accompanied by an 8 volt signal; 75% by a 6V signal, etc. C1 minimizes switching transients.

Operational amplifier, A1, is connected as a voltage follower and provides a usable output exactly equal to the voltage at the

divider. A1's output is applied to one side of the meter as the internal reference, to the VCO, and through a voltage divider to one input of operational amplifier A2. C2, R10 and C3 are feedback circuits to prevent oscillation. R11 is a current limiter to prevent burn-out. Q1 and R7 prevent latch-up. The VOLTAGE SOURCE ZERO pot (VSZ), R8, is adjusted for zero volts output with zero volts input, to eliminate any offset between A1 inputs. If the correction afforded by R9 is insufficient, an additional resistor is placed to +15 volts, or to -24 volts, to permit full correction.

The dc input to operational amplifier A2 is determined by voltage divider R12 through R16 and the DCV FULL SCALE switch. R15 and R16 are used in the 2V position, R15, R16 and R12 in the 1.414V position, and R15, R16 and R14 in the 1V position. DC OUTPUT CALIBRATE (OC), R13, is a fine adjustment of this divider.

The only differences between A2 and A1 operation is that A2 has ac feedback supplied by C6, and a booster amplifier consisting of complimentary emitter followers Q2 and Q3. With this configuration, the output current is supplied by Q2 and Q3 instead of A2 whenever the voltage drop across R13 exceeds 600mV. Hence, the output current capability greatly exceeds that of A2 alone. C6 and R20 is a feedback network to prevent oscillations caused by external capacitive loading. The DC OUTPUT ZERO (OZ) control, R17, is adjusted for zero output voltage when the % DEVIATION switch is in the zero position. Q2 and Q3 are protected against short-circuit by R22 and R24.

The voltage divider circuits are returned to common through their own wire (J17-12) to avoid stray power supply currents.

4-7 CRYSTAL OSCILLATOR (CARDS 6234 & 6235)

The two crystal oscillator cards each consist of a crystal controlled emitter coupled oscillator with nine crystals (one for each % DEVIATION), buffer, divider flip-flop, and output amplifier. The FREQUENCY GROUP switch determines which card is used; the % DEVIATION switch determines which crystal is used.

When the high frequency group is selected, a crystal on 6235 is used and the oscillator output is applied through the buffer, flip-flop and output amplifier on 6235. The flip-flop divides the oscillator signal by two. When the low frequency group is selected, a crystal on 6234 is used and that oscillator output is divided by its flip-flop and again by the flip-flop on 6235 before becoming the crystal oscillator output at J15, Pin D. This circuit configuration permits the crystals on both cards to operate at approximately the same frequency.

Depending on the FREQUENCY GROUP and % DEVIATION switch positions, a ground connection is made allowing current to flow in a pair of diodes. These diodes are then conducting and the appropriate crystal is placed in the oscillator circuit. R1, C2 and R10, C6 provide power supply decoupling. The oscillator consists of Q1 in a common base amplifier, Q2 as an emitter follower, and the crystal, operating in series resonance. CR1 and CR2 limit the oscillator amplitude. C7 rolls off the high frequency response, preventing oscillation at crystal harmonic frequencies. A small signal output is taken from the collector of Q2, and goes through C4 to Q3. CR3 protects Q3 and gives symmetrical clipping. Q3 is a buffer, isolating the oscillator from the flip-flop. R7 on 6235 is the common collector load for Q3 on 6235 and Q4 on 6234 (low band). When the low band oscillator is running, the high band oscillator isn't, and R6 cuts off Q3 of 6235. In the opposite case, R8 cuts off Q4 of 6234 so there is no interference.

The coupling circuits for Q3 and Q4 are similar and provide on-and-off voltage levels when driven and cut-off the transistors when not driven.

The output stage, Q4 and R9 of 6235, drives an RTL gate on the divider card (6232) and a flip-flop on the limiter card (6231).

4-8 DC INPUT AMPLIFIER (CARD 6238)

Operational amplifier A1 is used as a non-inverting amplifier with a gain ranging between 4 to 8. R1, R2, R10, R8, R9, and the DCV FULL SCALE switch determine gain. R10 is the bottom element of the divider in the 2V position, R10 and R1 in the 1V position. The output of A1 is applied to one side of the meter and is compared to the reference applied to the other side. The gain is adjusted for a full scale output of 8.000 volts so any difference indicated by the meter is the difference between the dc reference and the normalized dc from the demodulator under test. R3 and CR1 through CR4 limit the dc input between +5.7V and -5.7V to prevent amplifier damage. BIAS adjust R5, is adjusted to provide the input bias current for A1 so that the demodulator output impedance will not cause error. The DC IN CAL pot, R8, is adjusted for a gain of 5.656 (8.000/1.414) when on 1.414 volt DC FULL SCALE. This amplifier also amplifies the external modulating signal so it uses a different type of op. amp. which has greater high frequency capability.

The DC IN ZERO pot, R11, is adjusted for zero voltage offset in A1, as with the previously described circuits. R13, C2 and C3 are feedback circuits to prevent oscillations. Supply voltages are furnished by R15, CR6 and R14, CR5.

4-9 LOGIC POWER SUPPLY (CARD 1K06)

Differential amplifier, Q1 and Q2 amplifies the difference signal between the +3.6V reference established by R1 and R2 and the output voltage. The error signal from Q2's collector is applied to emitter follower Q3 which controls the conduction of series regulator Q4, which controls output voltage. R6 and C1 prevent oscillations. R7 and R8 maintain operation under light loading. CR1 and R5 provide an optimum supply voltage for Q3. The rectifiers are physically mounted on the main power supply card 1K01, and provide a partially filtered +7 volts to J19-7. Q4 and C2 are physically mounted on the chassis.

4-10 AUDIBLE VOLTMETER (6238)

Differential amplifier Q1 is connected across the meter. R19, R23, R24, R25, the RATE control, and Q3 comprise the constant-current source for Q1. The RATE control determines the current level to Q1. CR8 and CR9 limit error signals to 800mV. AUDIBLE VOLTMETER BALANCE, R20, is adjusted for a match between audible null and meter null. CR10 and CR11 couple the amplified absolute value of error to Q3. Q3 turns this into a current which charges C5, and thus determines the frequency generated by unijunction transistor Q4 and C5. Q5 is connected in the source follower configuration for impedance matching. R28, R29, and C6 couple a 3 volt sawtooth to the output, J18-5. The VOLUME control, R2, determines amplitude of sawtooth to pulse shaping network C7, R30, R31, R32, and CR12. The differentiated pulse is amplified by Q6. Q7 is an emitter follower which drives the speaker or headphones. Hence, there is a pulse output whose rate is proportional to meter error indication causing "clicks" on the speaker or headphones.

4-11 DIVIDER (CARD 6232)

The two divider chains on the divider card provide three functions: First, divides the crystal oscillator or VCO output to produce the correct test carrier frequency as determined by the % DEVIATION and CENTER FREQUENCY switches; second, divides the crystal oscillator output, and third, divides the output of the modulator under test an appropriate amount, to allow frequency comparison at one low frequency.

The lower divider chain shown in Figure 6-3 divides the internally generated signals. Depending upon the test to be performed, the internal divider is provided a signal from the crystal oscillator or the VCO (for internal modulation). When the modulator (VCO) self-check, internal square wave, or external modulation pushbuttons are depressed, J12 Pin 2 is grounded and the VCO signal enters the divider at Pin 3. With any other pushbutton depressed, J12 Pin 5 is grounded and the crystal oscillator signal enters the divider, at Pin 4.

The lower divider chain has two outputs. One output at the last flip-flop in the chain, A5-6, is applied to the frequency comparator as the internal standard. The second output, which becomes the test carrier, is taken from any one of the flip-flop outputs depending on the CENTER FREQUENCY switch position. The CENTER FREQUENCY switch grounds one input of the appropriate NOR gate in A1, A9, or A10 and the flip-flop output passes through the gate to the multiple input NOR gate, G2. An emitter follower, Q3, transmits the output of the gate to the output, pin N, eliminating loading effects. This output goes to the carrier amplifier. When the modulator-demodulator pushbutton is depressed, J14 pin 12 is ungrounded and connected to +3.6 volts, disabling the gate G2, and ultimately the test carrier output.

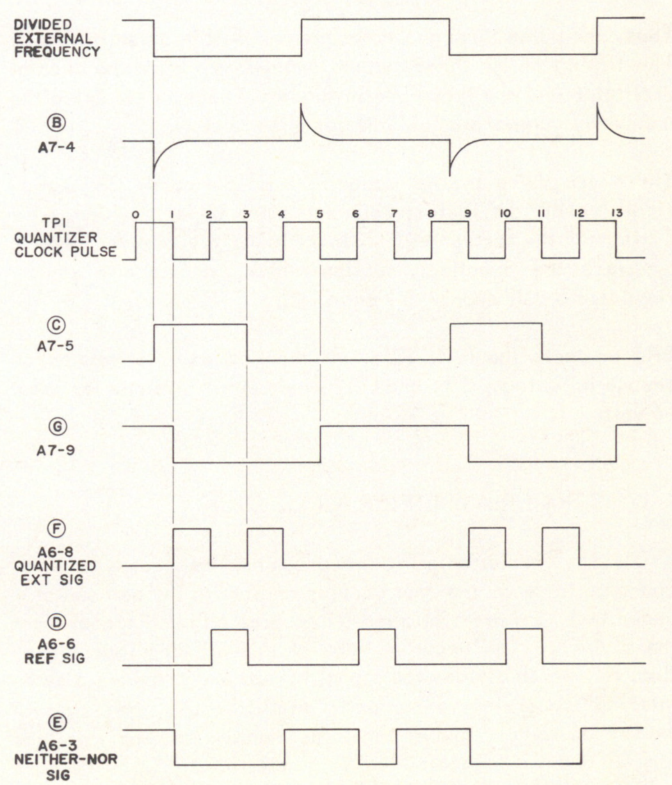
The upper divider chain divides the output of the modulator under test which has been passed through the limiter card. The CENTER FREQUENCY switch also grounds one input of the appropriate upper gate (A19, A11, A12) and the output appears at the other multiple-input gate, G1. This signal goes two places: through emitter follower Q2 to the frequency-difference detector A8 and through a differentiating network C4, R15, and R16 to the quantizer flip-flop A7.

The frequency-difference detector, A8, flips every time the negative edge of the square wave output of G1 passes a transition in the square wave at A4b output. If the modulator under test is exactly in synchronism with the Model 6200's crystal frequency standard, then there is no phase change and no audible output. A frequency error of 1% of center frequency (2.5% deviation) at low band will cause an A8 output of 135 Hz; at high band 1% of center frequency (3.3% deviation) will give 281 Hz. This is available as an audible output in MOD and MOD (INTERNAL CAL) modes.

The quantizer section (A5, A6, A7) produces three outputs:

- Pin D has a reference signal, a regular pulse train at a submultiple of the carrier frequency (approximately 3.4 or 7.0 kHz).
- Pin F has a quantized double pulse for every pulse that comes in through C4. This pulse is never present (high) when the D pulse is present.
- Pin E has a positive output when neither D nor F have output.

TYPICAL WAVEFORMS:



The reference pulse is produced by the A6a NOR gate acted on by the last two stages of the divider chain, the two sections of A5.

The neither-nor pulse is produced by the A6d NOR gate driven by the other two outputs.

The quantizer has four states:

(a) A rest state where A7-5 is low and A7-9 is high, causing A6-11 to be low. A7-2 is then low, and with both A7-2 and -3 low, A7a will not toggle as the clock line A5-6, TP1, etc.) runs. (A7a, indeed all flip-flops in this unit toggle on a negative-going transition.)

(b) When a negative transition comes through C4, A7-5 goes high and A7-6 goes low.

(c) When the next clock transition comes, A7-9 goes low. With A7-6 low and A7-9 low, A6-11 goes high, so

(d) when the next clock transition comes, A7-5 goes low, A7-6 goes high; and at the next clock transition, A7-9 goes high again, and it is back in the rest position.

A7-9 has been high for two clock pulse periods; that is to say, for two cycles of squarewave at A5-6, etc. These two waveforms are NOR'ed by A6c to produce the double pulse at pin F. Because pin D and pin F are NOR'ed with complementary outputs of A5, they can never be present at the same time.

Thus, one pulse through C4 causes one double pulse at Pin F. The timing of all three outputs are derived from the crystal oscillator and are therefore unvarying. These pulses drive the frequency comparator circuit described below.

There are three bypass capacitors on the card: C1 is physically near the fastest counter in the upper divider, A15; C2 is near the fastest counter in the lower divider, A2, and C3 bypasses the quantizer section which has its own zener-regulated 5 volt supply, R1 and CR2.

CR1 protects the RTL IC's. If the +3.6 volt line was to increase in voltage, CR1 and CR2 would limit this rise to about +6 volts.

4-12 CARRIER AMPLIFIER (CARD 6233)

The carrier amplifier ensures proper shape, symmetry, and amplitude of the test carrier applied to the demodulator under test. Emitter follower Q1 couples an input signal from the divider. The negative edge of this signal triggers flip-flop, A1, which divides the signal by two and provides a symmetrical square-wave output is amplifier Q2. Resistor R7 serves as vernier symmetry adjustment. The supply voltage for Q2 and Q3 is controlled by a dc follower, Q5. The base voltage to Q5 is determined by the CARRIER LEVEL control setting, and the carrier level is set by controlling the amplitude of Q2 output. Complimentary emitter followers Q3 and Q4 provide a low output impedance during the full swing of the output signal.

Diode CR1 temperature compensates Q5. Resistor R14 is selected to minimize carrier signal feed-through when the CARRIER LEVEL control is set to zero. R12 provides a 75 ohm output impedance; connecting R11 (150 ohms) lowers it to 50 ohms.

4-13 FREQUENCY COMPARATOR (CARD 6233)

The three signals on Pins D, E, and F of the frequency divider (Card 6232) are applied to three FETs that act as current switches. Q9 supplies a constant current to them and one of them is conducting, depending on the pulses applied to their gate terminals. The average currents produced are proportional to the reference and external frequencies and charge C8 and C7, respectively. The voltages developed by C8 and C7 discharging through R23 and R21, which are determined by the duty cycle of the input signals, are applied to the two inputs of the differential amplifier A3. The amplified difference, or error, signal is applied to the metering circuits through Pin 7.

The comparator zero control, R25, is adjusted for zero output with zero input error. R27, C10, and C11 prevent amplifier oscillations. R28 and C9 provide feedback and thus set the gain of the amplifier at about 50. CR5 prevents latch-up; R20 allows C7 to do some filtering, since the inverting input of the operational amplifier has a low effective impedance; R24 and R33 balance the circuit for true differential amplifier operation. C14 and C15 compensate for rise time differences in the input signal and slight differences in FET characteristics. The sensitivity of the comparator circuit, in volts per percentage frequency error, is proportional to the current being released through Q9. R17 is adjusted for the correct sensitivity at 0% DEVIATION. At other deviations, an external resistor selected by S4 provides compensation. This is necessary because the meter reads in percent of center frequency, but the reference signal changes with deviation.

4-14 INPUT LIMITER (CARD 6231)

Q1 and Q2 form a cascade amplifier with feedback. Q1 is an FET for high input impedance. R5 and R6 determine the amount of feedback. CR1 protects and aids Q2. Overall amplifier gain is 500. Hence, above 30 millivolts the amplifier saturates, but it maintains a reasonable duty cycle for all input signals within its required operating range. Q3 and Q4 make a Schmitt Trigger to square the input signal. CR2 limits the negative swing of the input. R12, R14, R17, and R18 bias Q3 and Q4. CR4, CR5, and R21 couple the output to the logic circuits.

The NOR gates in A1 control the output to the divider. During modulator testing, the limiter output signal from Q4 is passed through A1a and A1b to the divider. The gate terminal is

pulled high by R20 so A1d is unable to pass any signal.

During self-check of the frequency comparator or VCO, the internal crystal oscillator signal is routed through flip-flop A2, gate A1d and then gate A1b to the divider because the gate is low. A1a is now unable to pass a signal. A2 divides the crystal oscillator frequency by two since the carrier amplifier flip-flop also divides by two. Thus, both inputs to the divider are of the same frequency, when the CENTER FREQUENCY switch is set to the highest frequency.

4-15 REGULATED POWER SUPPLY (CARD 1K01)

The Model 6200 has internal regulated power supplies that convert 115/230 ±10% ac line power (48-64Hz) to +24 volt dc and -24 volt dc. The power supply regulators have good line and load voltage regulation: Line regulation is about ±1 millivolt over a ±10% line voltage variation. Load regulation is about 2 millivolts. Noise and 120Hz ripple on all supplies should be less than about 400 microvolts peak-to-peak.

Refer to Figure 6-9. For positive dc, the output of power transformer T-1 is full-wave rectified by CR7 and CR10 and filtered by C3. For negative dc the transformer output is rectified by CR8 and CR9 and filtered by C4. C9 and C10 suppress high frequency transients from the power line.

The -24 volt supply is regulated by power transistor Q2* which is controlled by emitter follower Q7. Q7 is part of a negative feedback circuit that amplifies output voltage variations and feeds them back to the regulator transistor Q2* to compensate for the original voltage variation.

The amplifier feedback circuit monitors the voltage at the center arm of R-33 which is part of a voltage divider from the -24 volt bus to ground. A differential amplifier (Q9 and Q11) circuit compares this voltage to the voltage across a zener diode reference. Any difference between the two voltages is amplified and then amplified again by another differential amplifier circuit (Q10 and Q12). Transistor Q8 is a current source that acts as a high impedance collector load for Q10. The signal at the collector of Q10 controls Q7 which in turn controls the regulator transistor Q2* to compensate for output voltage variations. Poentiometer R33 adjusts the -24V output.

(*Q2 on the chassis, part number 48:22:2032.)

With two exceptions the positive and negative regulators have identical circuits. One exception is of course voltage polarity which in turn requires complimentary transistors. The other exception is the voltage references for the differential amplifier (Q3 and Q6).

The positive regulator is referred to the -24 volt supply by the voltage divider R15, R16 and R17 which is connected from the +24 volt remote sense line to the -24 volt bus. The other voltage reference is the ground sense line which is connected through R9 to the base of Q3. If the +24 volt sense line voltage changes the voltage at the base of Q6 will change also and the feedback circuit will compensate for the original voltage change. Similarly, if the -24 volt supply should drop out of regulation (e.g., short-circuit or if F2 blows) then the +24 volt regulator will drop out also. The potentiometer R16 adjusts the +24 volt supply.

SECTION V

MAINTENANCE AND CALIBRATION PROCEDURES

5-1 INTRODUCTION

This section provides calibration and maintenance information for the Model 6200 FM Calibrator. This instrument is designed to provide long, trouble-free service with only periodic adjustment.

If the instrument is to be shipped to MICOM for service or repair, attach a tag to the instrument identifying the owner and indicate the necessary service or repair. See Section 2-7 for packing instructions. Ship to:

Service Department
MICOM, Incorporated
855 Commercial Street
Palo Alto, California 94303

If there are any questions we can answer, write or phone (415) 328-2961. In any correspondence, identify the instrument by model and serial number.

5-2 TEST EQUIPMENT

Refer to Table 5-1 for recommended test equipment for performance checking and troubleshooting. Other instruments may be used if their specifications or performance equals or exceeds the required characteristics.

5-3 INSTRUMENT COVER REMOVAL

Unscrew and remove the six countersunk Phillips-head screws holding each cover on. Covers may then be lifted off with a slight backwards then upwards motion. When replacing the covers, make sure the top cover which has a rubber strip inside is put back on top.

5-4 TROUBLESHOOTING AND REPAIR

When malfunction is suspected, disconnect the instrument from all equipment and perform the self-check pro-

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED INSTRUMENTS
DC Differential Voltmeter	0.01% accuracy from 1 to 10 volts	Fluke 883A
Electronic Counter	Time base accuracy 0.002% 1 kHz to 2 MHz	HP 3734A
Oscilloscope	Bandwidth: DC to 15 MHz Sensitivity: 0.01 to 10V/division Sweep: 1 msec/div to 0.5 usec/div	Tektronix Type 422
Sine Wave Generator	1 kHz to 1.2 MHz, 10mV to 3VRMS	HP 651B
Millivolt DC Source	0 to 450mVDC	- - -
Square Wave Generator	1 kHz; 1 µsec risetime	Wavetek 110
Ohmmeter	Accuracy 0.2% or as required. Test voltage less than 5 volts.	Fluke 853A

TABLE 5-1 - RECOMMENDED TEST EQUIPMENT

cedure given in Table 5-3. If the instrument self-checks properly, check that the dc and frequency outputs are within specification. Make sure that the connecting cables which are used do not make intermittent connection, especially in 75 ohm systems. If the malfunction persists, go through the Performance Checks and Calibration Procedure, Section 5-8 through 5-14 to help determine the location of the trouble.

5-5 SUBSTITUTION

Trouble is greatly simplified if checking is done by replacing a suspected plug-in card with one known to be operating properly. When a malfunctioning card is found, the trouble may be traced to the offending component or the card returned to MICOM for repair.

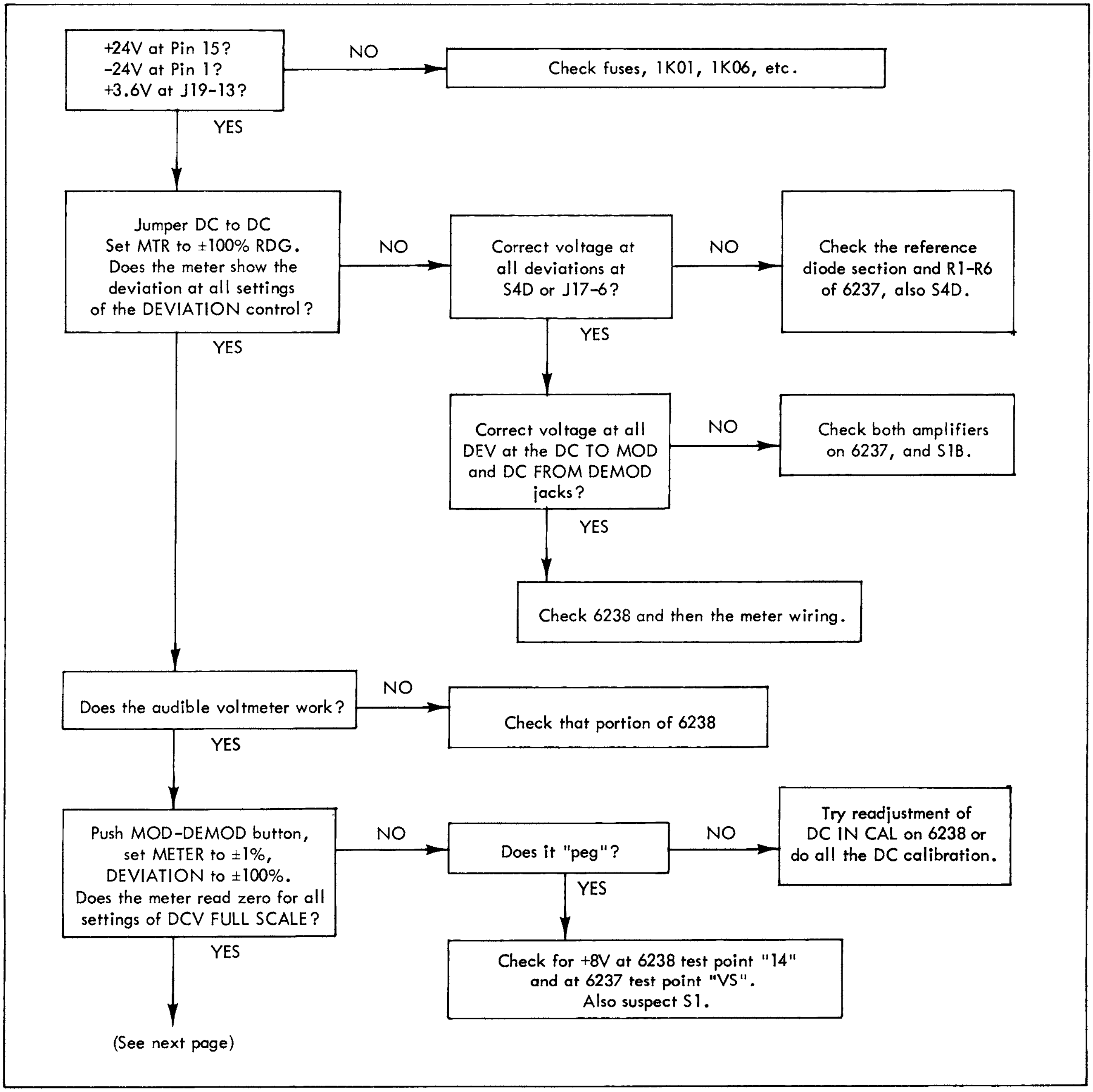


TABLE 5-3 - TROUBLESHOOTING PROCEDURE

5-6 TROUBLESHOOTING OF CIRCUIT CARDS

Refer to Section IV, Principles of Operation, for details on the operation of all assemblies used in the Model 6200. Refer also to the schematic of each circuit card for key waveforms and operating dc levels to help isolate faulty components. For easy access to operating plug-in cards, use the PC board extender included with the instrument, attached to the card cage behind the front panel.

5-7 PRINTED CIRCUIT COMPONENT REPLACEMENT

To prevent damage to the circuit board, apply heat sparingly and work carefully. Use a $37\frac{1}{2}$ watt iron with a small, clean tip. Replace components as follows:

a. Remove defective component. In many cases, you may be able to cut off the body of the component leaving a portion of the lead. Each lead may be removed, with heating, with a minimum of force.

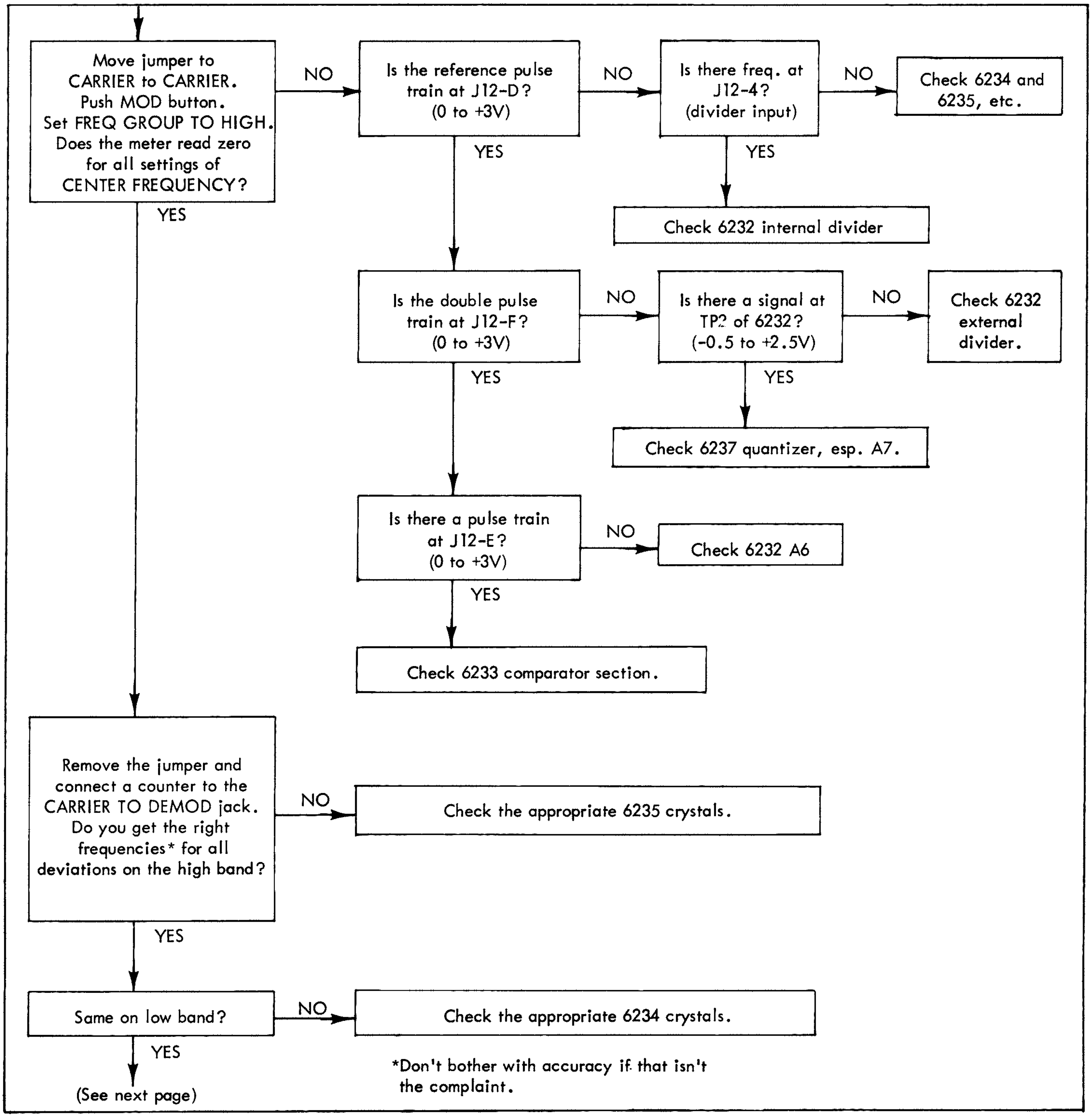


TABLE 5-3 - TROUBLESHOOTING PROCEDURE

b. Melt the solder in the component lead holes and quickly clear the holes with a suction type solder removal tool or with a thin toothpick. Do not use sharp, pointed objects; they may damage the plated-through holes.

c. Bend the leads of the replacement component to fit and insert the component leads in holes. Solder leads in place, using heat and solder sparingly.

d. If this operation has lifted a pad with a trace, re-melt the solder and push the pad back against the board allowing the solder to cool so that the component lead holds the pad firmly in place.

5-8 PERFORMANCE CHECKS AND CALIBRATION

GENERAL

Remove the instrument covers for access to the instrument interior. You may use the extender board supplied (MICOM Part No. 1KF5) unless specifically instructed otherwise. For test points and component identification, refer to the photograph to the left of the corresponding schematic.

CAUTION

Be sure to turn off the power switch and wait two seconds before removing or replacing a circuit card.

Especially avoid shorting Pins D, E and F of J12 and J13 to each other or ground. This will ruin A6 of Card 6232.

When only one terminal is mentioned in a measurement, the other terminal is ground; you may use the chassis, the rail going through Pin 10 of every PC socket or the ground bus between the front panel BNC jacks.

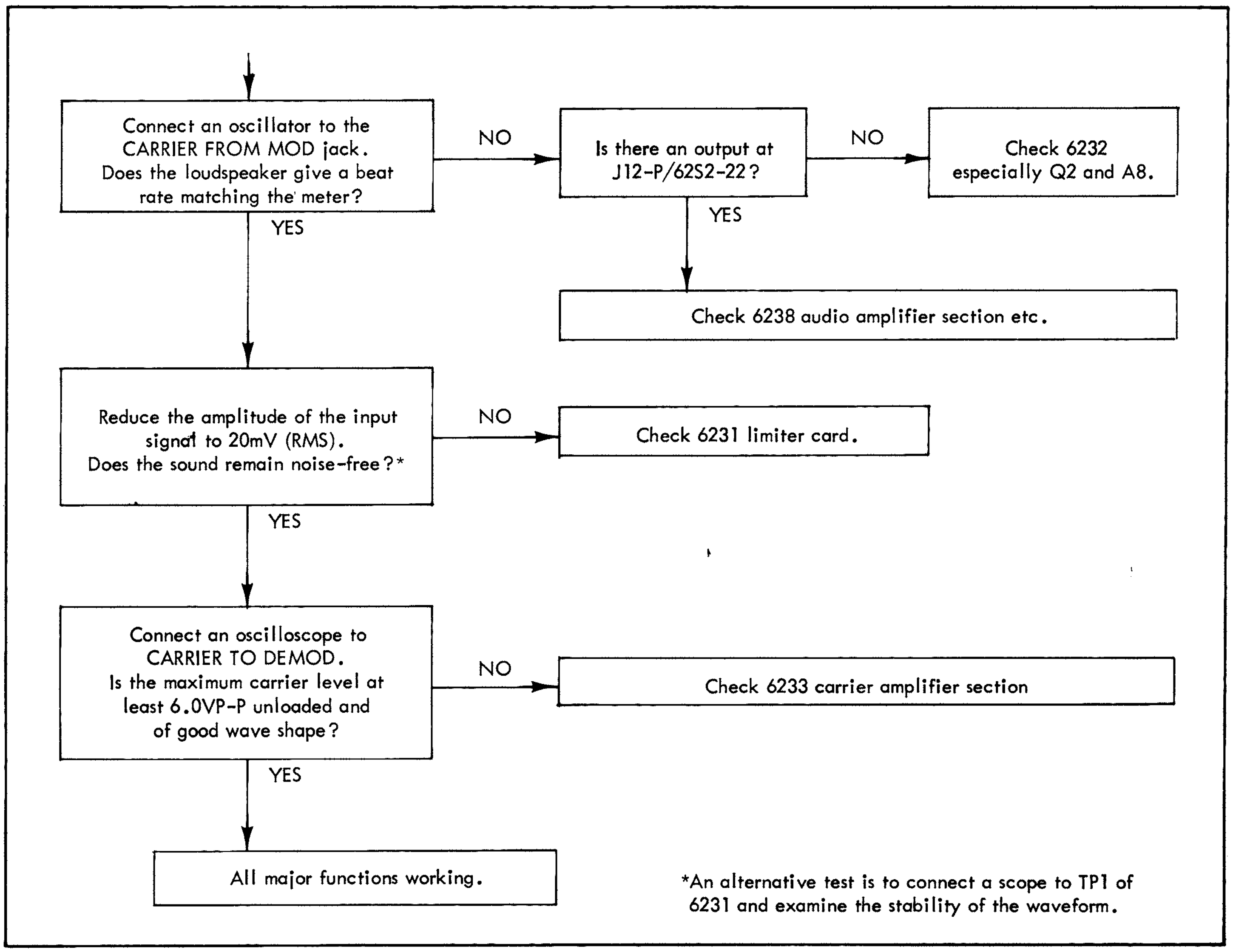


TABLE 5-3 - TROUBLESHOOTING PROCEDURE

5-9 POWER SUPPLY

a. Set line voltage to normal value, 115 or 120 Vac.

b. The -24V supply rail (Pin 1 on any PC socket) should read -24.00V ±20mV. If not, adjust the "-24" pot on Card 1K01.

c. Vary line voltage from 103 to 127 Vac. The -24V rail should not vary more than ±3mV.

d. The +24V supply rail (Pin 15 on any PC socket) should read +24.00V ±20mV, with normal line voltage. If not, adjust the "+24" pot on Card 1K01.

e. Vary line voltage from 103 to 127 Vac. The +24V rail should not vary more than ±3mV.

f. The +3.6V supply, 6231 OR J11 ~~J21~~ Pin 13, should read between +3.40 and +3.80V.

g. Reduce line voltage to 103 Vac. The +3.6V line should drop less than 0.1V.

5-10 PRECISION DC SUPPLY

a. Set the Model 6200 controls as follows:

% FS DEVIATION: 0
DCV FULL SCALE: ±1.414

b. The voltage source output, J17 Pin 7 or the "VS" test point on Card 6237, should read 0 volts ±2mV. If not, adjust the VSZ pot on that card.

c. The dc output, J17-4 or the "OC" test point on Card 6237, should read 0 volts ±2mV. If not, adjust the OZ pot on that card.

d. Set the % FS DEVIATION switch to +100%.

e. The "VS" test point should read +8.000V ±8.0mV. If not, adjust the VSC pot on that card.

f. The "OC" test point should read +1.414V ±2.8mV. If not, adjust the OC pot on that card.

g. Set the % FS DEVIATION switch to -100%.

h. The "OC" test point should read -1.414V ±2.8mV. If not, adjust the OC pot so that steps f) and h) both are satisified.

i. Rotate the % FS DEVIATION switch through all positions and verify the following:

% FS DEVIATION	"OC" VOLTAGE ±0.0028V
-25	-0.3536V
-50	-0.7071V
-75	-1.0607V
+75	+1.0607V
+50	+0.7071V
+25	+0.3536V

j. Set the DCV FULL SCALE switch to ±1.0 and rotate the % FS DEVIATION through these positions and verify the following:

% DEVIATION	"OC" VOLTAGE TO ±0.0020V
-25	-0.2500
-50	-0.5000
-75	-0.7500
-100	-1.000
+100	+1.000
+75	+0.7500
+50	+0.5000
+25	+0.2500

k. Set the DCV FULL SCALE switch to ±2.0 and verify the following:

% DEVIATION	"OC" VOLTAGE TO ±0.0040V
-25	-0.5000
-50	-1.0000
-75	-1.5000
-100	-2.0000
+100	+2.0000
+75	+1.5000
+50	+1.0000
+25	+0.5000

1. Reset the % FS DEVIATION to +100%. Measure the voltage drop when a 50 ohm load is connected to the DC TO MOD jack. This should be less than 0.4mV either at the "0C" test point, or even at a tee connector directly mounted on the jack and making good contact.

5-11 PRECISION DC INPUT

Check that the terminating resistors provide the specified input resistance: PRESS EXT_SIG

a. Connect the ohmmeter to the DC FROM DEMOD jack. Set the TERMINATION switch to 10M; the reading should be greater than 10 megohms. Set the switch to 10K and read 10.0K ±1%. Set the switch to 1K and read 1.00K ±1%. Set the switch to 600 ohms and read 604 ohms ±1%. Set the switch to 75 ohms and read 75.0 ohms ±1%.

5-12 FREQUENCY SOURCE

a. Set the CENTER FREQUENCY switch to 900 kHz, FREQUENCY GROUP to HIGH, CARRIER LEVEL to its midpoint and % FS DEVIATION to +100%.

b. Adjust the "SYM" pot on the 6233 card for the most symmetrical carrier output at the CARRIER TO DEMOD jack. The ratio between the two half periods should be at most 0.45 to 0.55. The rise and fall times shall be less than 0.1 microseconds.

c. Adjust CARRIER LEVEL for minimum output; it shall be less than 0.1 volts peak-to-peak.

d. Adjust CARRIER LEVEL for maximum output; it shall be at least 6.0 volts peak-to-peak.

e. Check the output frequency accuracy for the following frequencies. The tolerances listed make no allowance for inaccuracies in your frequency counter.

On HIGH band:

%FS DEV.	FREQ.	TOLERANCE
+100	1170.0	±0.117
+75	1102.5	±0.110
+50	1035.0	±0.103
+25	967.5	±0.097
0	900.0	±0.090
-25	832.5	±0.083
-50	765.0	±0.076
-75	697.5	±0.070
-100	630.0	±0.063

On LOW band:

%FS DEV.	FREQ.	TOLERANCE
+100	604.8	±0.060
+75	561.6	±0.056
+50	518.4	±0.052
+25	475.2	±0.048
0	432.0	±0.043
-25	388.8	±0.039
-50	345.6	±0.035
-75	302.4	±0.030
-100	259.2	±0.026

f. Now set % FS DEVIATION to "0", the FREQ GROUP switch back to HIGH and check the output frequency at these positions of the CENTER FREQUENCY switch:

kHz	FREQ.	TOLERANCE
450	450.000	±0.045
225	225.000	±0.023
112	112.500	±0.011
56	56.250	±0.006
28	28.125	±0.003
14	14.063	±0.002
7.03	7.0312	±0.002
3.51	3.5156	±0.001

g. Press the MOD-DEMOD button. The carrier must cease.

5-13 FREQUENCY COMPARATOR ALIGNMENT

a. Push the FREQ. COMPAR. button and set the METER RANGE switch to ±1%. Adjust the front panel COMPAR. pot for a zero meter reading. If the range of adjustment is not enough, reset that pot back to mid-position and adjust the "CZ" pot (comparator zero) pot on the 6233 card for a zero meter reading. (Note that this is one of two different rest positions of the needle; the next time the unit is switched to FREQ. COMPAR. mode it may come to rest at the other reading which is slightly different. In actual use, this is not a detriment because when the frequency is very close, the error indication becomes the rate of needle "kicks", not needle position.)

NOTE PRESS MOD BUTTON UNDER "FULL TEST CATEGORY"

b. Push the MOD button and connect a stable oscillator to the CARRIER FROM MOD jack. Set the METER RANGE switch at 30%. With the % FS DEVIATION switch at 0 and a CENTER FREQUENCY selection of 900 kHz, set the oscillator at 981.000 kHz*, 100mVrMS, and adjust the "CS" pot (comparator sensitivity) on the 6233 card for +30% ±0.5%.

*If the oscillator won't go this high, pick any lower center frequency and set the oscillator exactly 9% higher for HIGH band or 12% higher for LOW band.

c. Reduce the oscillator level to 20 millivolts rMS; the meter reading must continue to be steady. If not, the limiter circuit on card 6231 is not operating properly.

d. Reset CENTER FREQUENCY to 3.38 kHz. Turn the FREQUENCY GROUP, METER RANGE and the % FS DEVIATION switches to the positions in Table 5-4, at each position adjusting the oscillator for a + full scale meter deflection. Check the oscillator frequency against the limits given. If outside these limits, check the resistor indicated.

5-14 ADJUSTMENT SUMMARY

NOTE: If there is any doubt about the full functioning of the instrument, consult the Performance Checks and Calibration, Section 5-5.

The following adjustments should be done only by those with a thorough knowledge of the instrument. It is assumed that the instrument is warmed up.

Meter. The meter mechanical zero affects all measurements.

Power Supplies. The -24V adjustment affects the +24 volt line, and they both have a small effect on most of the other adjustments. The adjustment sequence is:

1) Adjust the "-24" pot on card 1K01 for -24 volts (±20mV) on the Pin 1 bus.
2) Adjust the "+24" pot on the same card for +24 volts (±20mV) on the Pin 15 bus.

DC Circuits' Zero. There are two zero adjustments in the precision dc supply and two in the dc input amplifier and they will affect both zero and non-zero dc comparisons.

3) Set % FS DEVIATION to 0, METER RANGE to ±30%,

BAND	METER RANGE	DEVIATION	HIGH LIMIT	LOW LIMIT	CALIBRATION RESISTOR	
LOW	30%	0			15.4K	S6
LOW	10%	0	3.518 kHz	3.502 kHz	5.23K	S6
LOW	3%	0	3.419	3.412	1.62K	S6
LOW	1%	0	3.392	3.386	562 ohm	S6
LOW	30%	-100	2.453	2.407	16.9K	S4
LOW	30%	-75	2.790	2.745	26.1K	S4
LOW	30%	-50	3.128	3.082	44.2K	S4
LOW	30%	-25	3.465	3.420	100K	S4
LOW	30%	+25	4.140	4.095	178K	S4
LOW	30%	+50	4.478	4.432	82.5K	S4
LOW	30%	+75	4.815	4.770	51.1K	S4
LOW	30%	+100	5.153	5.107	36.5K	S4
HIGH	30%	-100	5.587	5.522	26.1K	S4
HIGH	30%	-75	6.114	6.050	38.3K	S4
HIGH	30%	-50	6.642	6.577	64.9K	S4
HIGH	30%	-25	7.169	7.104	137K	S4
HIGH	30%	+25	8.224	8.159	237K	S4
HIGH	30%	+50	8.751	8.686	115K	S4
HIGH	30%	+75	9.278	9.214	75.0K	S4
HIGH	30%	+100	9.805	9.741	51.1K	S4

TABLE 5-4 FREQUENCY COMPARATOR CALIBRATION CHART.

DCV FS to ±1.414, TERMINATION to 10M and push the MOD-DEMOD button. With all jacks open, adjust the "BIAS" pot on 6238 card for a rough zero meter reading. (This provides a bias current for 6238-A1 at this temperature, minimizing change with source resistance.)

4) Adjust the "VSZ" pot on 6237 for 0 (±1mV) at the VS test point, adjacent.
5) Adjust the "OZ" pot on that card for 0 (±0.7) at the OC test point, adjacent.
6) Set TERMINATION to 1K, METER RANGE to ±1% and adjust the "Z" pot on 6238 for a zero meter reading. (A final test would be to jumper the two dc jacks together and still read zero.)

DC Circuits' Calibration. There are two calibration adjustments in the precision dc supply and one in the dc input amplifier which will affect all non-zero dc comparisons.

7) Set DEVIATION to +100% and adjust the "VSC" pot (far right) on the 6237 card for +8.000 volts (±4mV) at the VS test point.
8) Adjust the "OC" pot on that card for +1.4142 volts (±1.4mV) at the OC test point.
9) Put a jumper between the DC TO MOD and DC FROM DEMOD jacks. Adjust the "CAL" pot on the 6238 card for a zero meter reading.

Meter Calibration. There is a calibration trimming adjustment for the meter which is mostly effective on the ±1% range. It doesn't affect other ranges much and zeros not at all.

10) Provide a 59.4K resistance between the dc jacks or otherwise put a +14.14mV signal into the DC FROM DEMOD jack. Adjust the "MTR" pot on 6238 for a full scale meter reading. (MOD-DEMOD mode, ±1% METER RANGE).

Frequency Comparator. There are no adjustments on the crystal oscillators, but there is a zero adjustment and a calibration adjustment on the frequency comparator. The zero adjustment affects all frequency comparison readings, but not dc readings.

11) Set the CENTER FREQUENCY switch fully clockwise (432/900) and push the FREQ. COMPAR. button. Adjust the front panel "COMPAR" for a zero meter reading. (If the range of adjustment is not enough, reset it to mid-position and use the "CZ" pot on 6233.) (METER RANGE ±1%.)
12) Connect an accurate source of 3.780 kHz to the CARRIER FROM MOD jack; set CENTER FREQUENCY to 3.38 kHz, DEVIATION to 0, METER RANGE to ± 30%, FREQ. GROUP to LOW and push the MOD button. Adjust the "CS" pot on 6233 for a full scale meter reading.

Audible Voltmeter. There is a balance adjustment for this circuit that makes the audible null match the meter null; it affects no other circuit in the instrument.

13) Set meter range to ±3%, TERMINATION to 1K, remove all input to the DC FROM DEMOD jack and push the DEMOD button. The meter should read zero. Varying the VOLUME and RATE controls to keep a slow audible click rate, adjust the "AV BAL" pot on 6238 for a minimum click rate.

Carrier Symmetry. If it is desired, the symmetry of the carrier output can be given a fine adjustment. It affects nothing else in the instrument.

14) Set FREQUENCY GROUP to HIGH, CENTER FREQUENCY, to 900, connect the CARRIER TO DEMOD jack to its normal load and set the CARRIER LEVEL control for the normal level. Adjust the "SYM" pot on 6233 for maximum symmetry, determined either by an oscilloscope or by the reaction of your demodulator.

5-15 SPECIAL INSTRUCTIONS FOR TROUBLESHOOTING THE QUANTIZER (FREQUENCY COMPARATOR LOGIC)

1) Setup by pushing the FREQ. COMPAR. button. Using external sync, synchronize your oscilloscope on the negative slope of the waveform at test point T2 of the 6232 card.

2) Adjust the sweep speed so that the waveform at T2 is low for exactly four vertical divisions and high for four divisions, etc.

3) Look at test point T1 and adjust horizontal position so that the first negative transition falls exactly on line 1.

4) Look at A7 Pin 5. The waveform should be high at the beginning of the trace and should fall at line 3. (If it isn't high, then the negative pulse at A7 Pin 4 isn't setting A7a; check that it falls below +0.6 volts) The waveform at A7 Pin 6 should be the opposite.

5) Look at A7 Pin 9. The waveform should go down at line 1 and up at line 5.

6) Look at A7 Pin 2. The waveform should go up at line 1 and down at line 3.

7) Look at A6 Pin 1 or J12-F. There should be a double pulse, up at line 1, down at 2, up at 3, down at 4. (If this waveform is missing and the previous waveforms are present, A6c has been ruined, probably by shorting the output.)

8) Look at A6 Pin 6 or J12-D. It should be high either between lines 2 and 3 or lines 4 and 5, and repeat every 4 lines. Note which position it is at. (If this waveform is missing and there are square waves at Pins 4 and 5, then A6a has been ruined.)

9) Look at A6 Pin 3 or J12-E. If the previous waveform was between lines 4 and 5, this waveform will rise at line 2, fall at line 3, rise at line 5 and fall at line 8. If the opposite state has occurred, this

waveform will rise at line 4, fall at 6, rise at 7 and fall at 9.

(If this waveform is missing and the two previous waveforms are present then A6d has been ruined.)

PARTS REPLACEMENT INVOLVING SELECTED PARTS:

1) If one of the operational amplifiers (A2 on 6233, A1 and A2 on 6237 and A1 on 6238) has to be replaced, it may be found that the zeroing adjustment has inadequate range. In this case, try adding a resistor at one of the "selected component" positions. If the zeroing pot is at the ground end, add a resistor (6 megohm or below) to -24 volts. If instead, the zeroing pot is at the +15V end, add a resistor (2 megohm or below) to +15 volts. Film resistors are preferred.

2) If the voltage reference diode, CR3 on 6237, were replaced, it might be found that the calibration pot VSC has inadequate range. In this case, change R2 to whatever value will permit proper calibration. A stable resistor is needed, metal film or wire-wound.

3) If Q2 or Q5 of 6233 is replaced, it may be found that the "zero" position of the CARRIER LEVEL control gives excessive carrier output. This may be corrected by changing the value of R14.

SECTION VI

SCHEMATICS

6-1 SCHEMATIC DIAGRAMS

6-1.1 This section contains the schematic diagrams necessary for maintenance and calibration of the Model 6200 FM Calibrator. Each diagram illustrates the circuits on each plug-in card and all associated switches, switch assemblies, connectors, and related components.

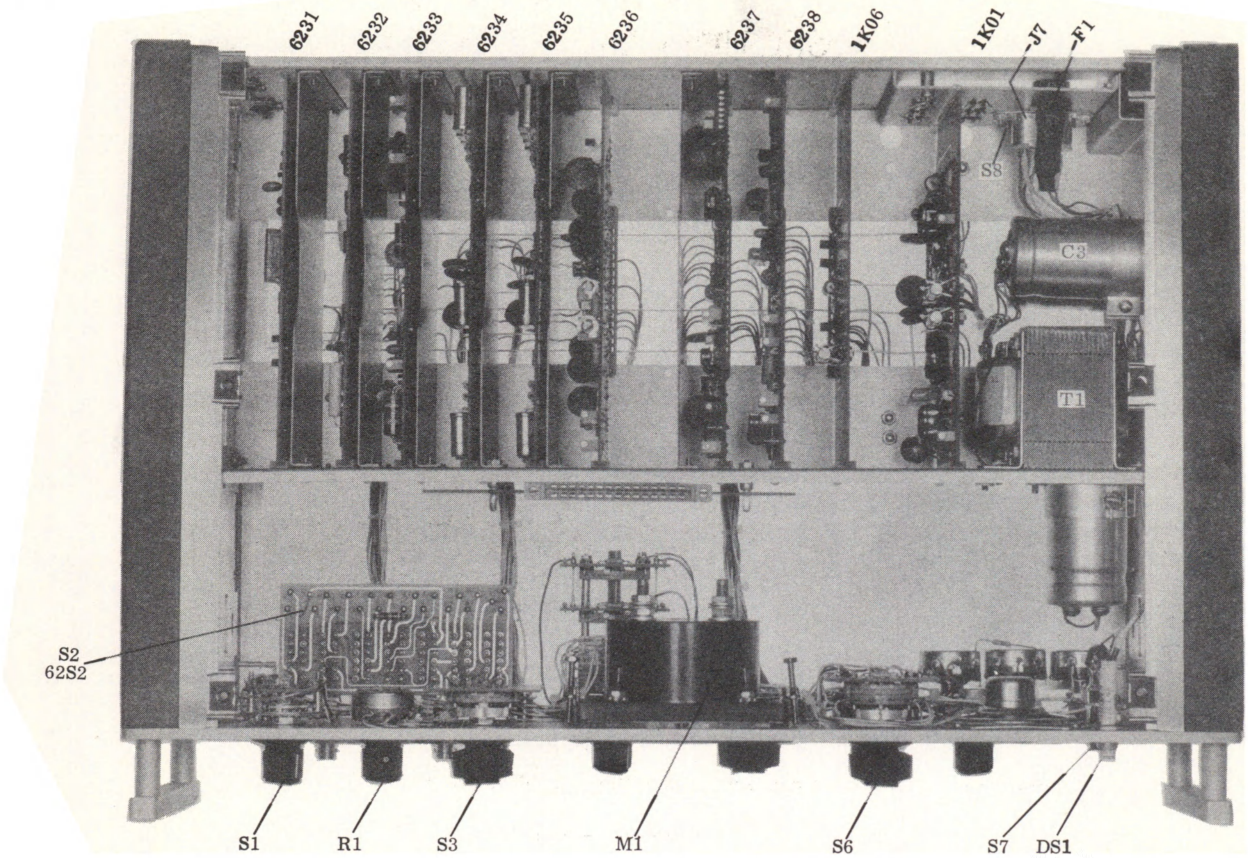
6-1.2 The following conventions are used on all drawings:

1. Components mounted on the card are enclosed within a dotted outline.
2. Front panel designations are enclosed with a box, as shown:

TEST FREQUENCY

3. Component values marked ▲ are nominal. Optimum values are selected at the factory, or may be omitted.

6-1.3 Figure 6-1 on page 6-2 shows the location of all cards, connectors, and controls in the package.



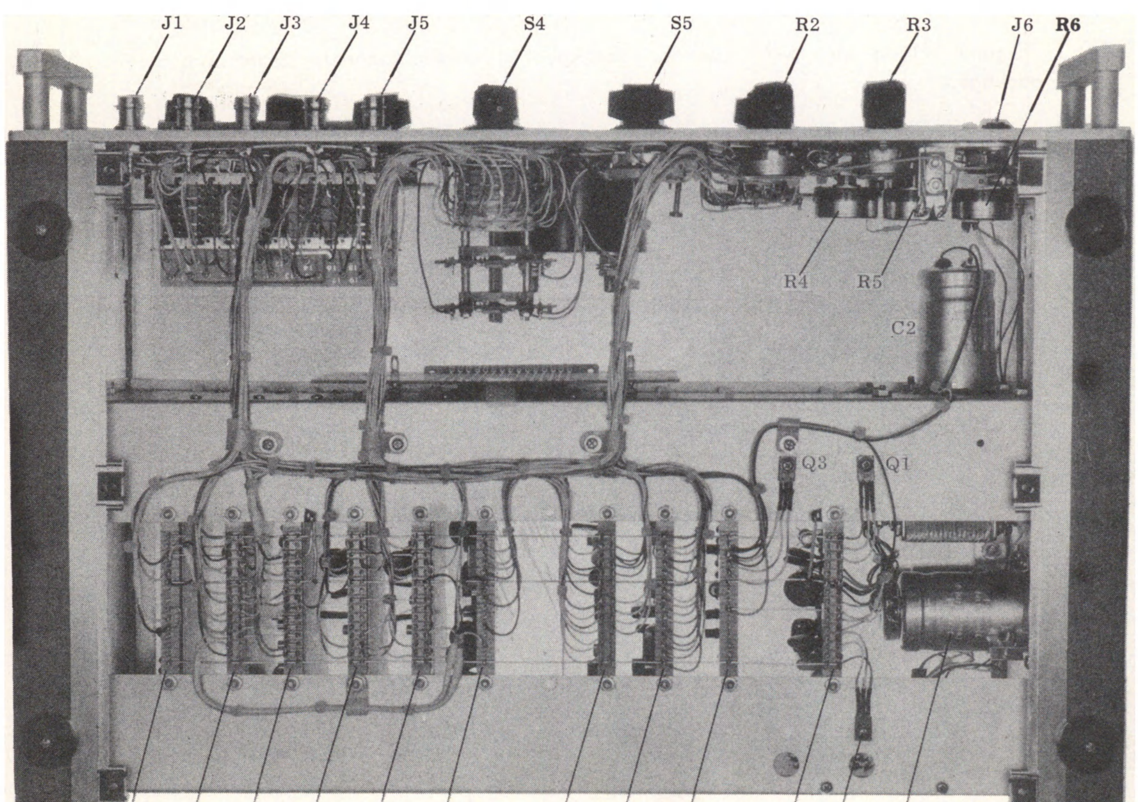
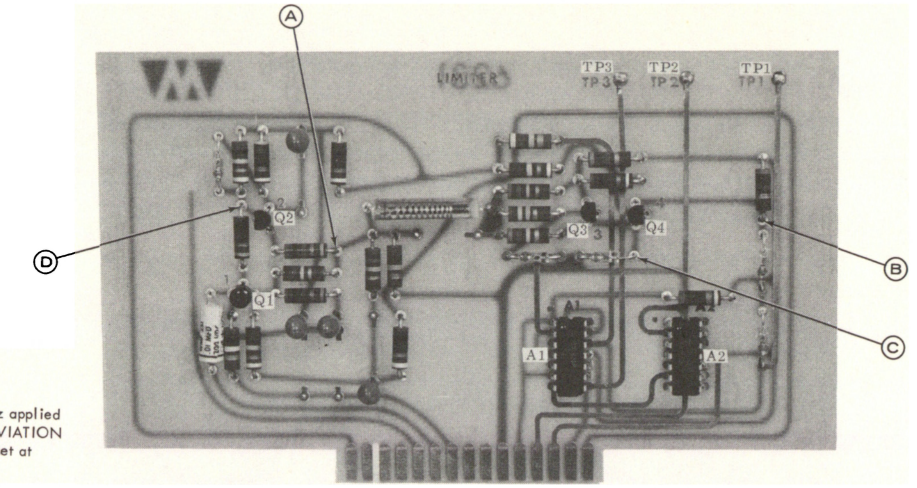


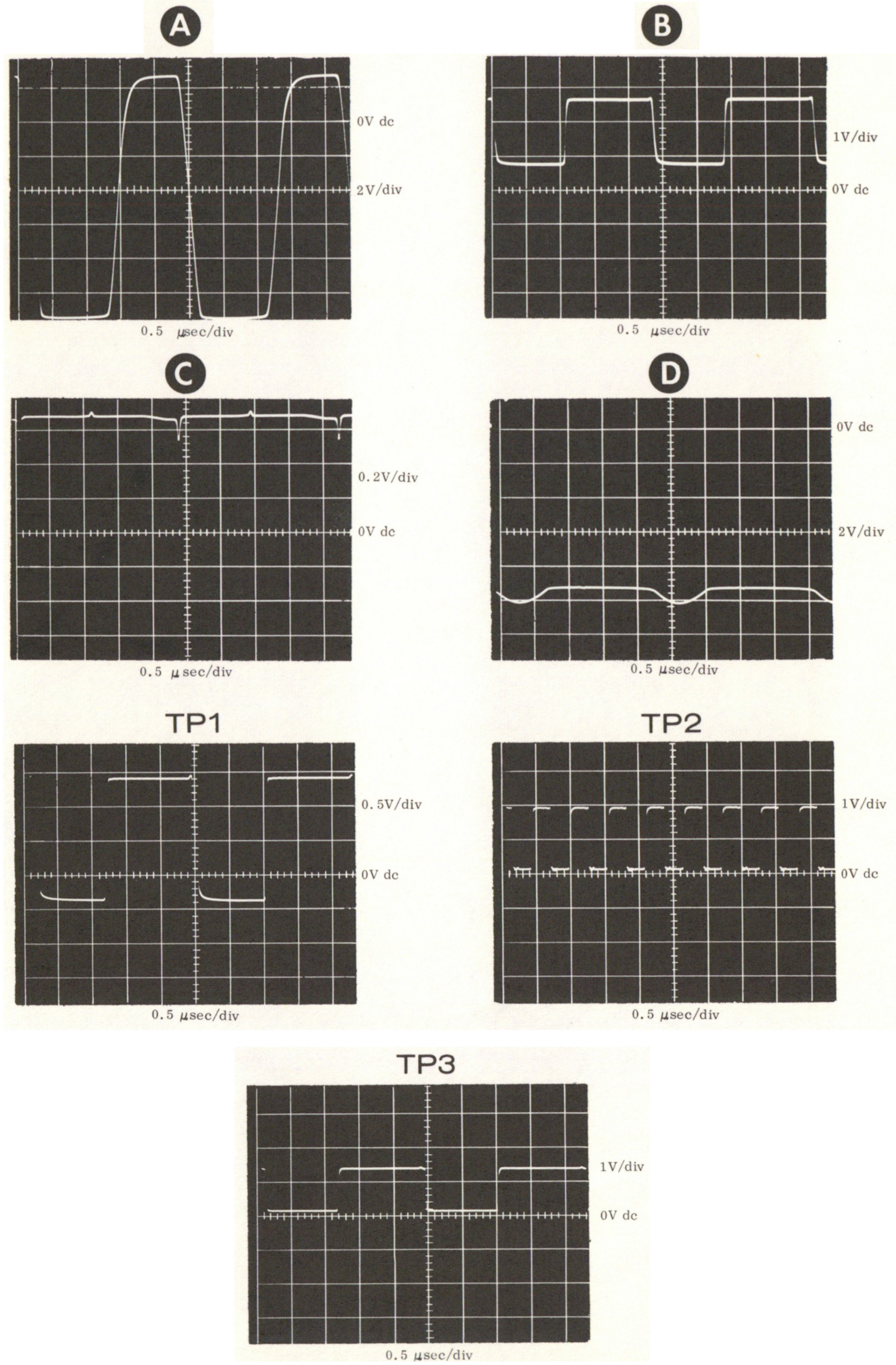
Figure 6 - 1 TOP AND BOTTOM INTERIOR VIEWS

6231



Test Conditions

Input: 0 1V rms at 432kHz applied to carrier from MOD. DEVIATION set at 0, FREQ. GROUP set at HIGH.



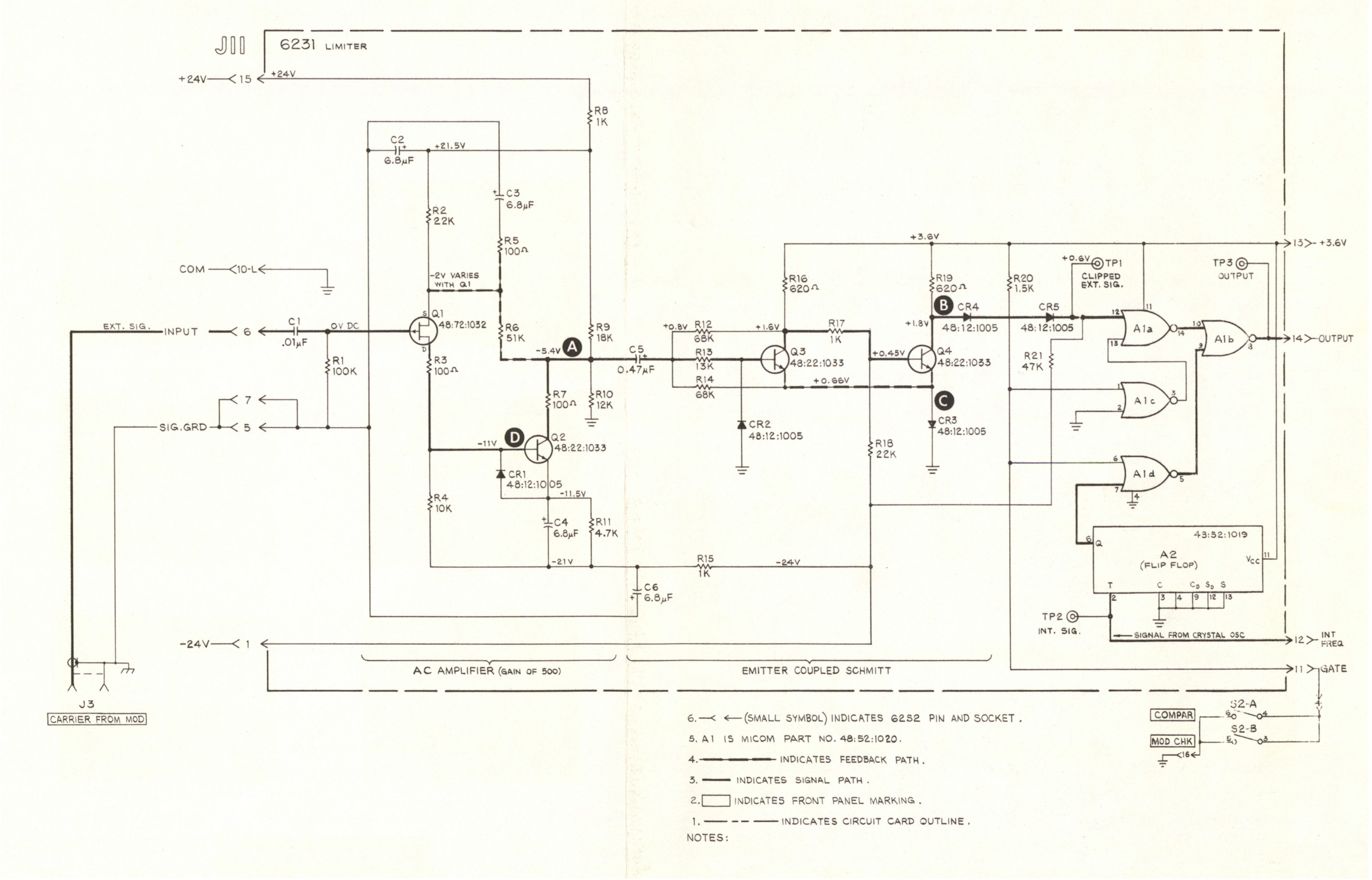


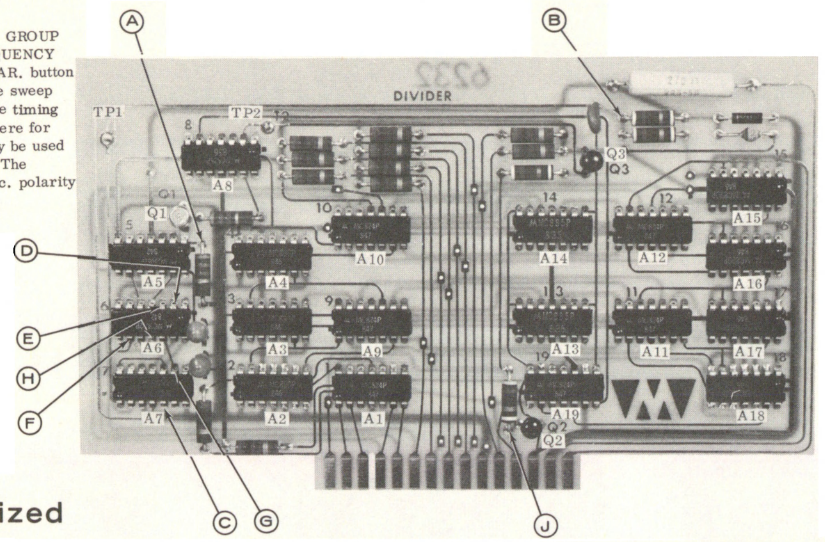
Figure 6 - 2 Card 6231

LIMITER

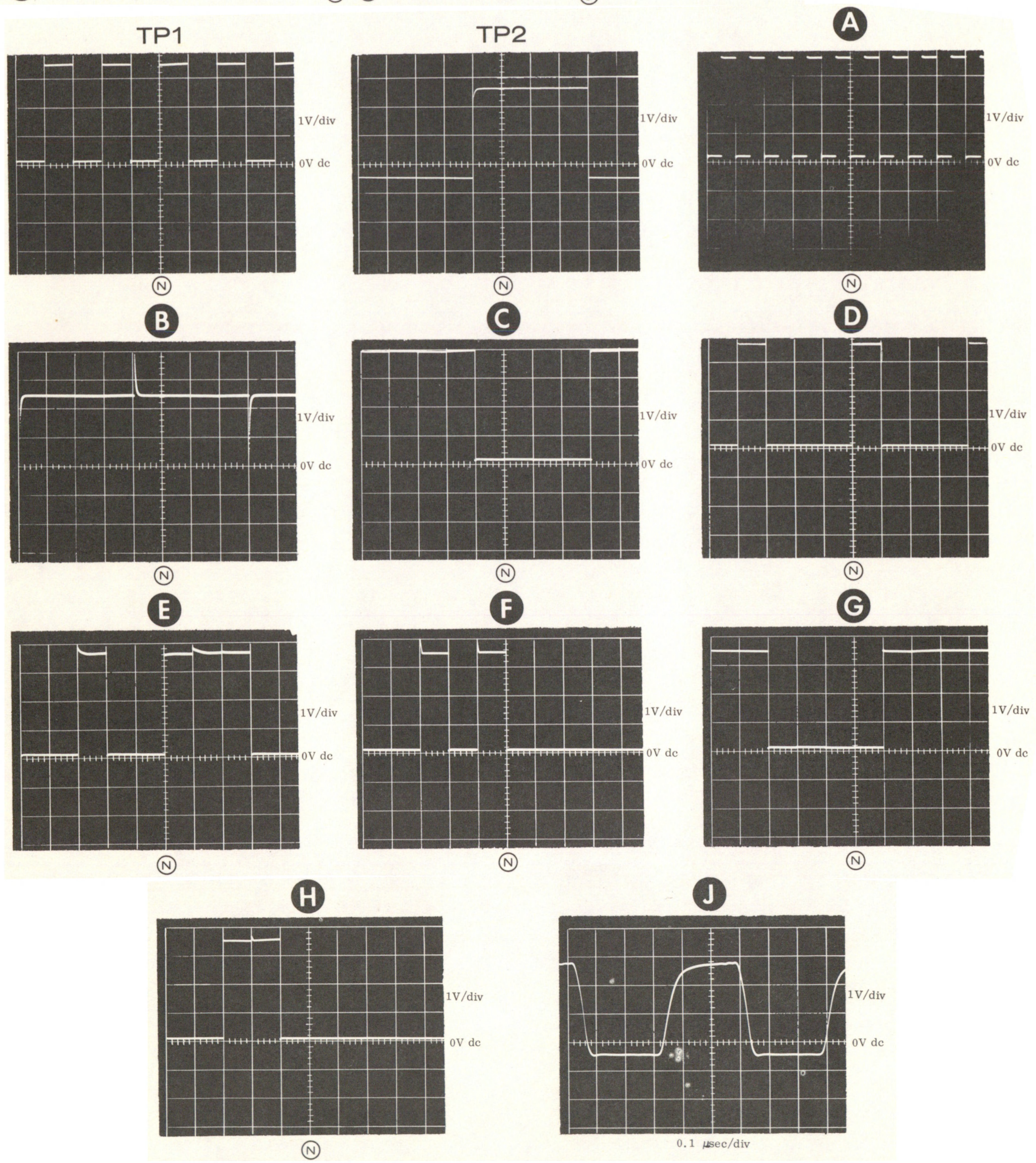
6232

Test Conditions

DEVIATION set at 0, FREQ. GROUP set at HIGH, CENTER FREQUENCY set at 900kHz FREQ. COMPAR. button depressed. The oscilloscope sweep is adjusted to give exactly the timing shown at TP1 and then left there for the other pictures. TP2 may be used as an external sync. point. The position of the trace and sync. polarity will have to be adjusted.



Ⓝ = Normalized



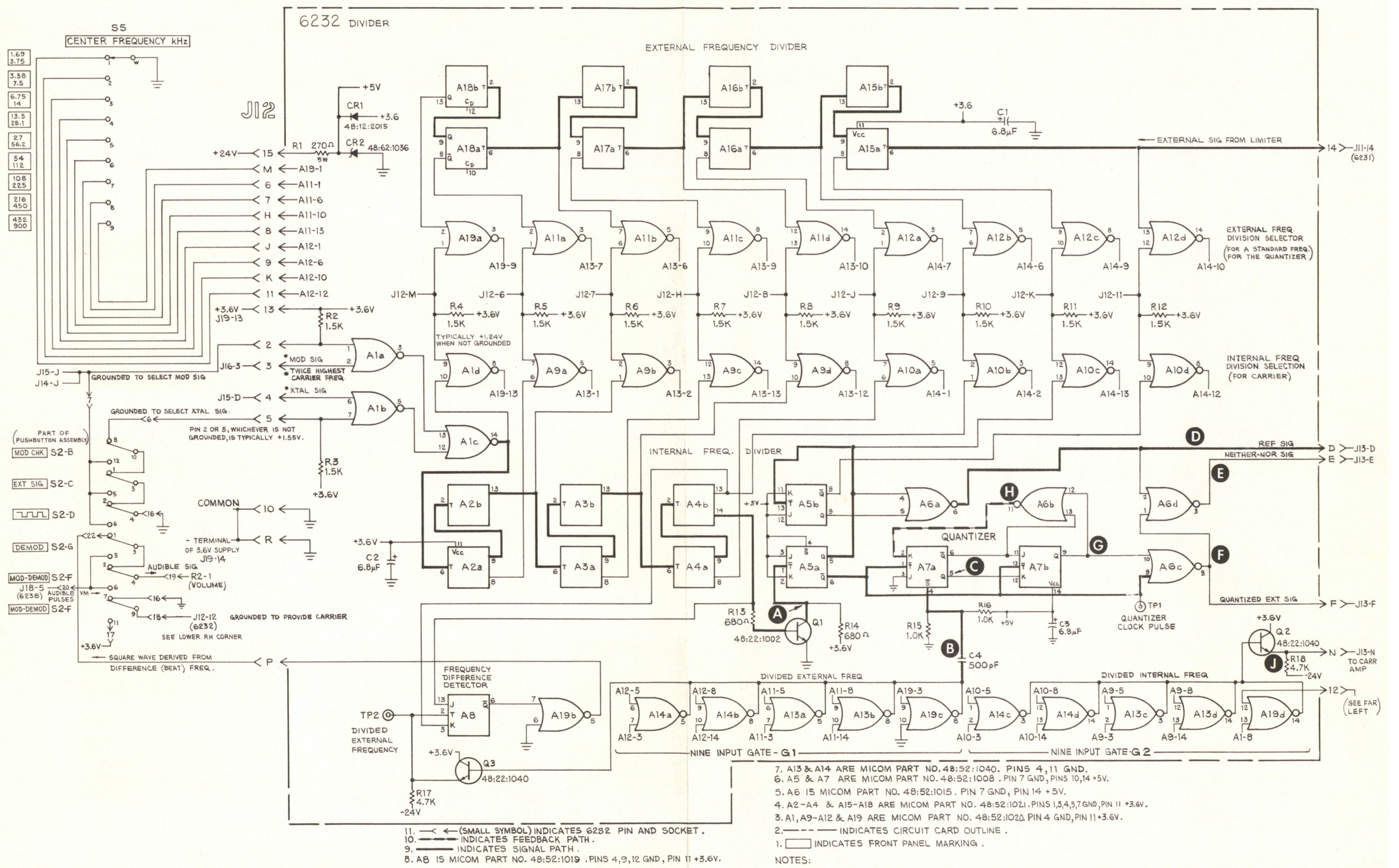
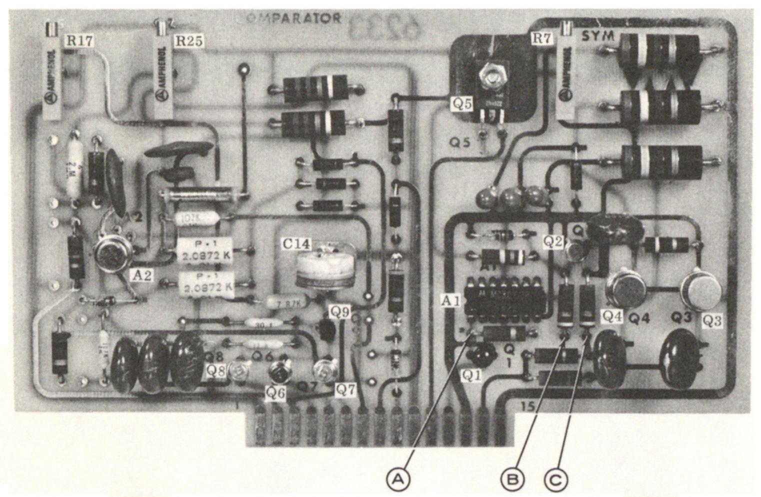


Figure 6 - 3 Card 6232

FREQUENCY DIVIDER

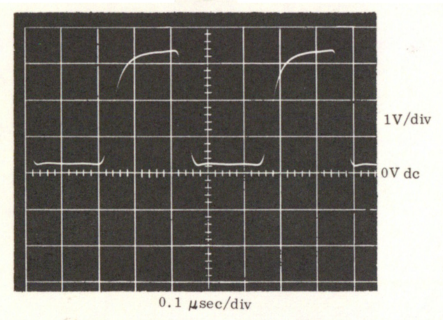
6233



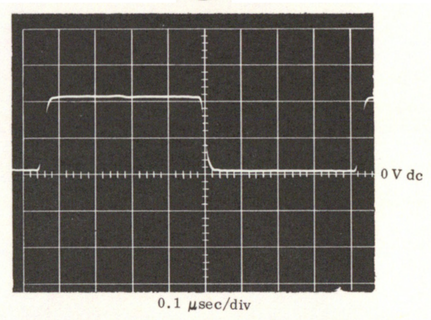
Test Conditions

DEVIATION set at +100%, FREQ. GROUP at HIGH, CENTER FREQ. at 900kHz, CARRIER LEVEL at 5. Do not push MOD-DEMOD button.

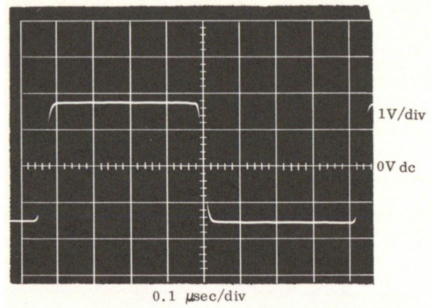
A



B



C



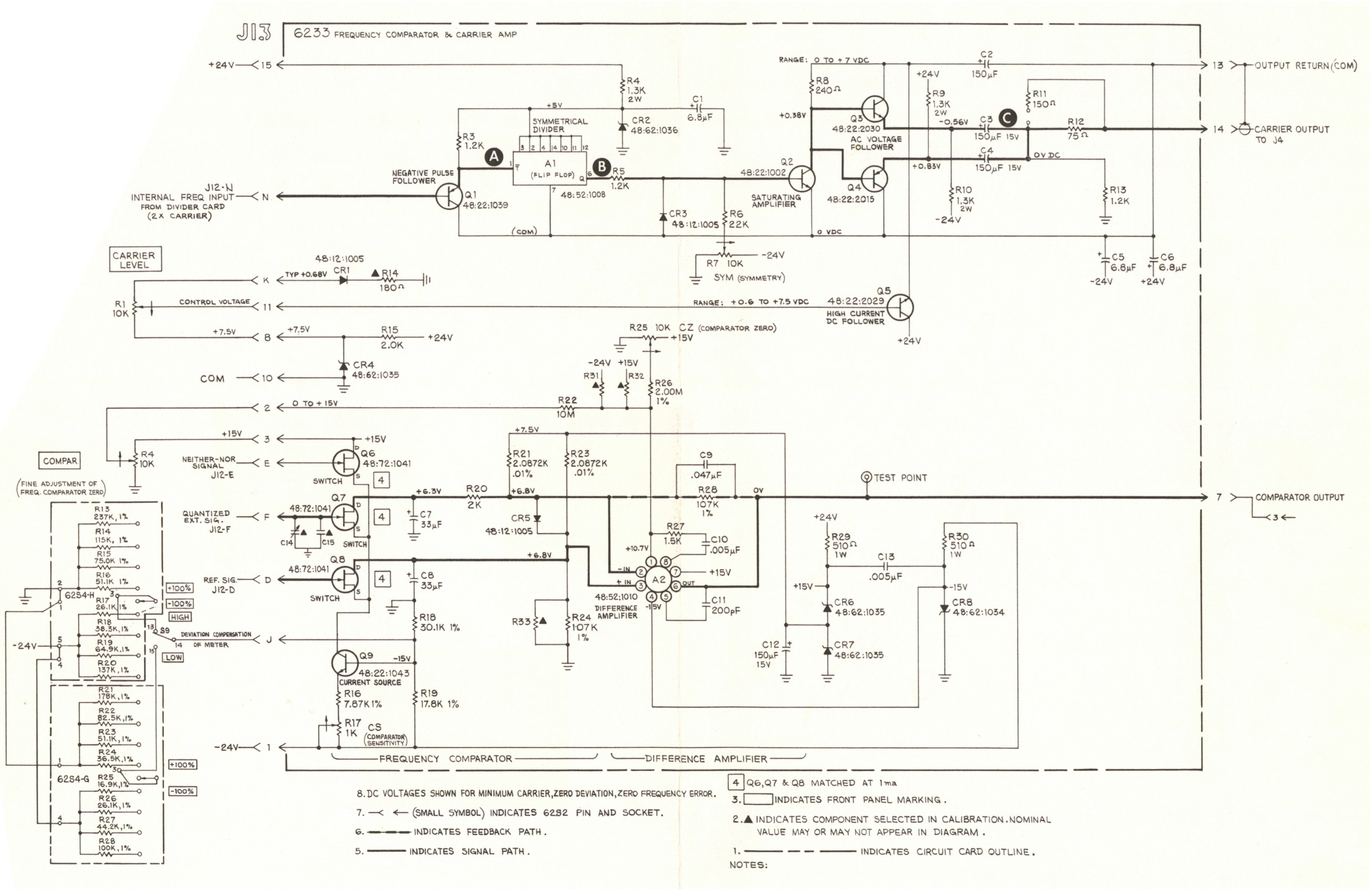
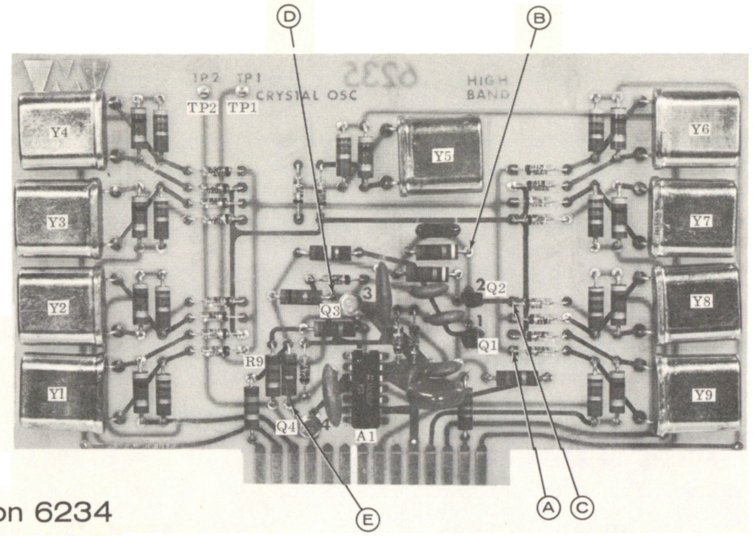


Figure 6 - 4 Card 6233

FREQUENCY COMPARATOR

6234-6235

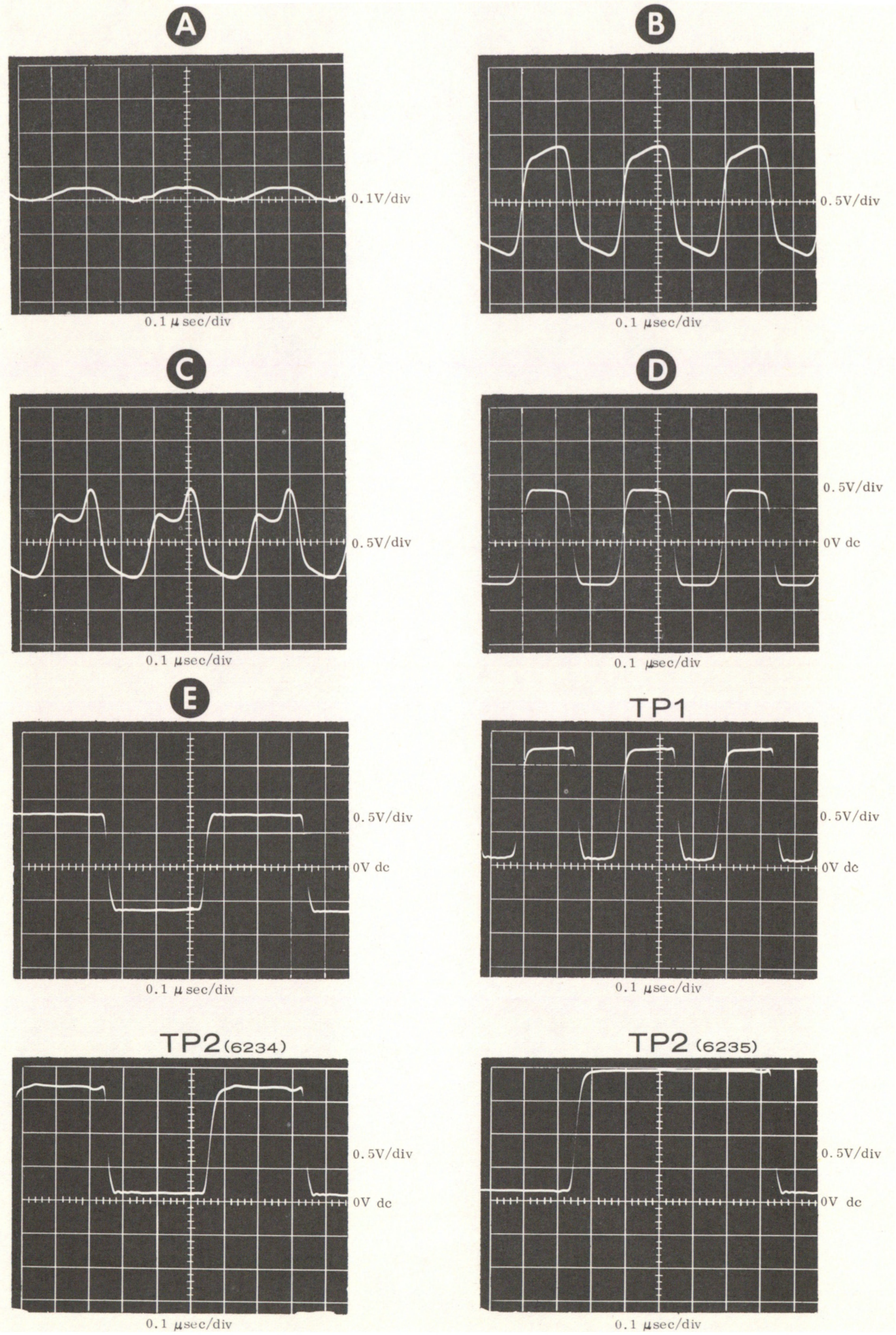


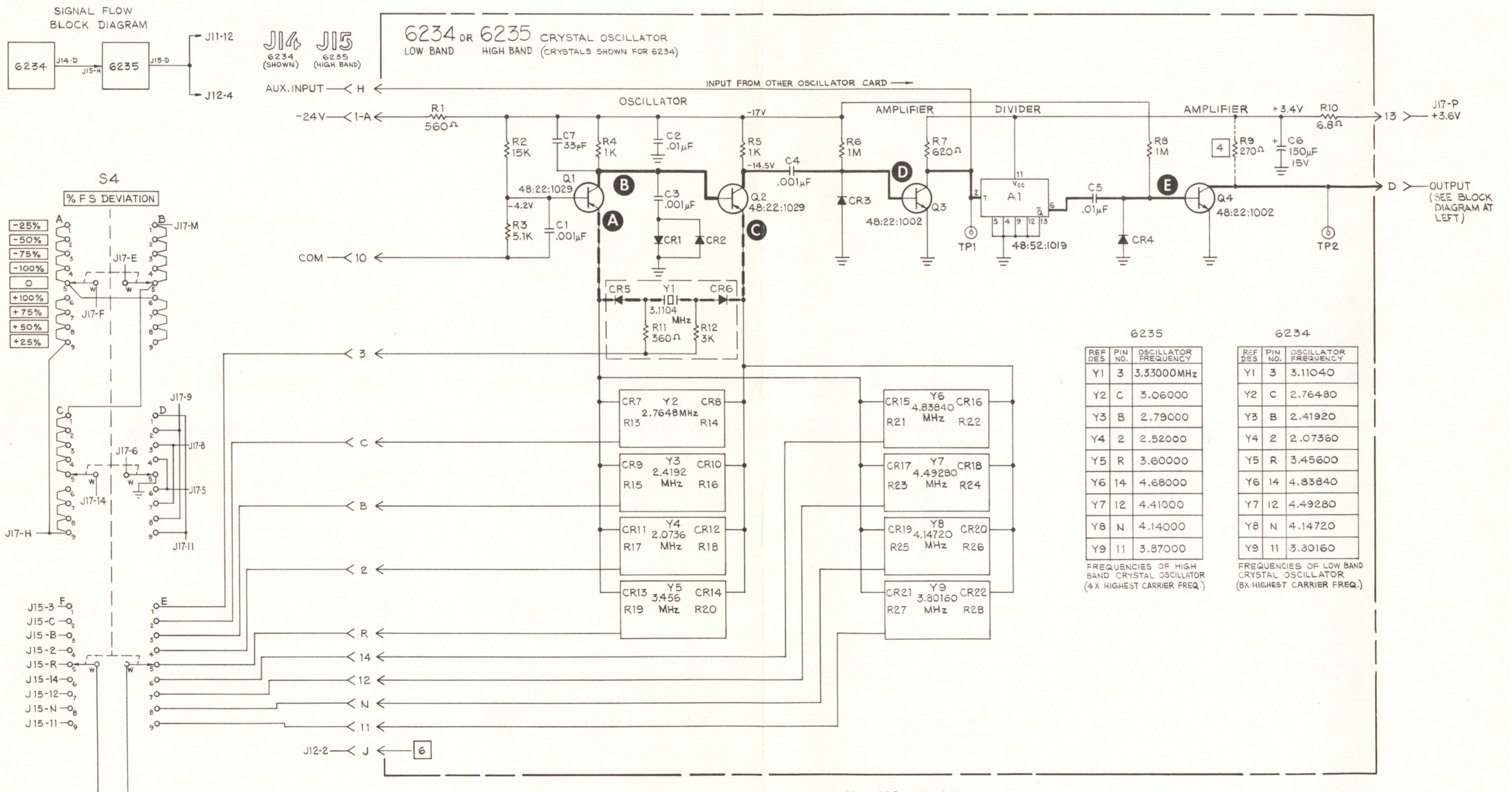
Test Conditions

DEV:0 FREQ. GROUP LOW

The first seven pictures are of 6234, the last one is of 6235 under these conditions. They are, however, typical in amplitude and risetime for all frequencies.

R9 Not used on 6234





REF DES	PIN NO.	OSCILLATOR FREQUENCY
Y1	3	3.33000MHz
Y2	C	3.06000
Y3	B	2.79000
Y4	2	2.52000
Y5	R	3.60000
Y6	14	4.68000
Y7	12	4.41000
Y8	N	4.14000
Y9	11	3.87000

6235: FREQUENCIES OF HIGH BAND CRYSTAL OSCILLATOR (4X HIGHEST CARRIER FREQ.)

REF DES	PIN NO.	OSCILLATOR FREQUENCY
Y1	3	3.11040
Y2	C	2.76480
Y3	B	2.41920
Y4	2	2.07360
Y5	R	3.45600
Y6	14	4.83840
Y7	12	4.49280
Y8	N	4.14720
Y9	11	3.30160

6234: FREQUENCIES OF LOW BAND CRYSTAL OSCILLATOR (8X HIGHEST CARRIER FREQ.)

NOTES:

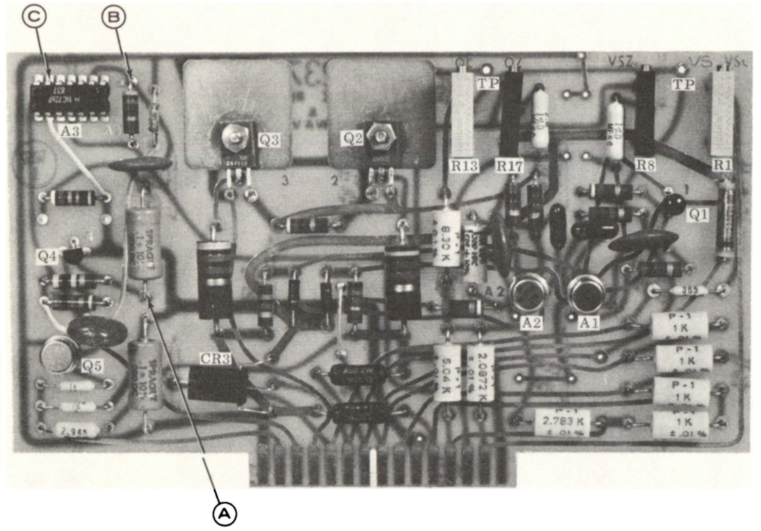
1. THIS SCHEMATIC USED FOR HIGH BAND (6235) AND LOW BAND (6234).
2. — — — INDICATES CIRCUIT CARD OUTLINE.
3. ☐ INDICATES FRONT PANEL MARKING.
4. THIS RESISTOR USED ON HIGH FREQUENCY CIRCUIT ONLY (6235). DELETE FOR LOW FREQUENCY CIRCUIT (6234).
5. CR1-CR22 ARE 48:12:1005.
6. THIS CONNECTION NOT USED WITH A FULL COMPLEMENT OF CRYSTALS.
7. ——— INDICATES SIGNAL PATH.
8. ▬ ▬ ▬ INDICATES FEEDBACK PATH
9. DC VOLTAGES SHOW ON OPERATING OSCILLATOR.

Figure 6 - 5

Cards 6234 or 6235

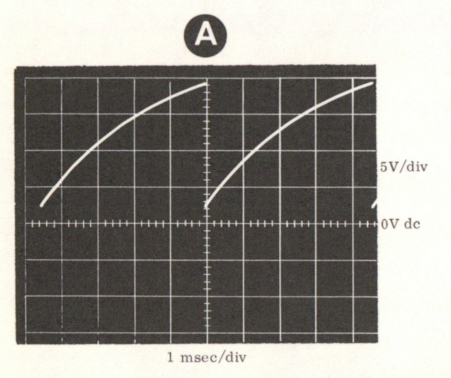
CRYSTAL OSCILLATOR
High and Low Band

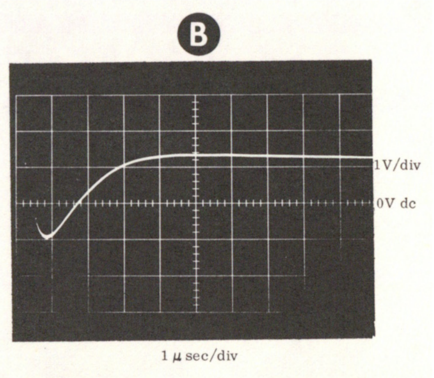
6237

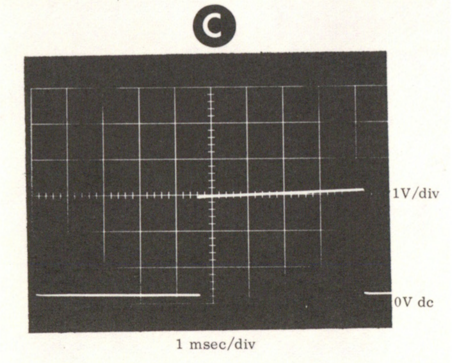


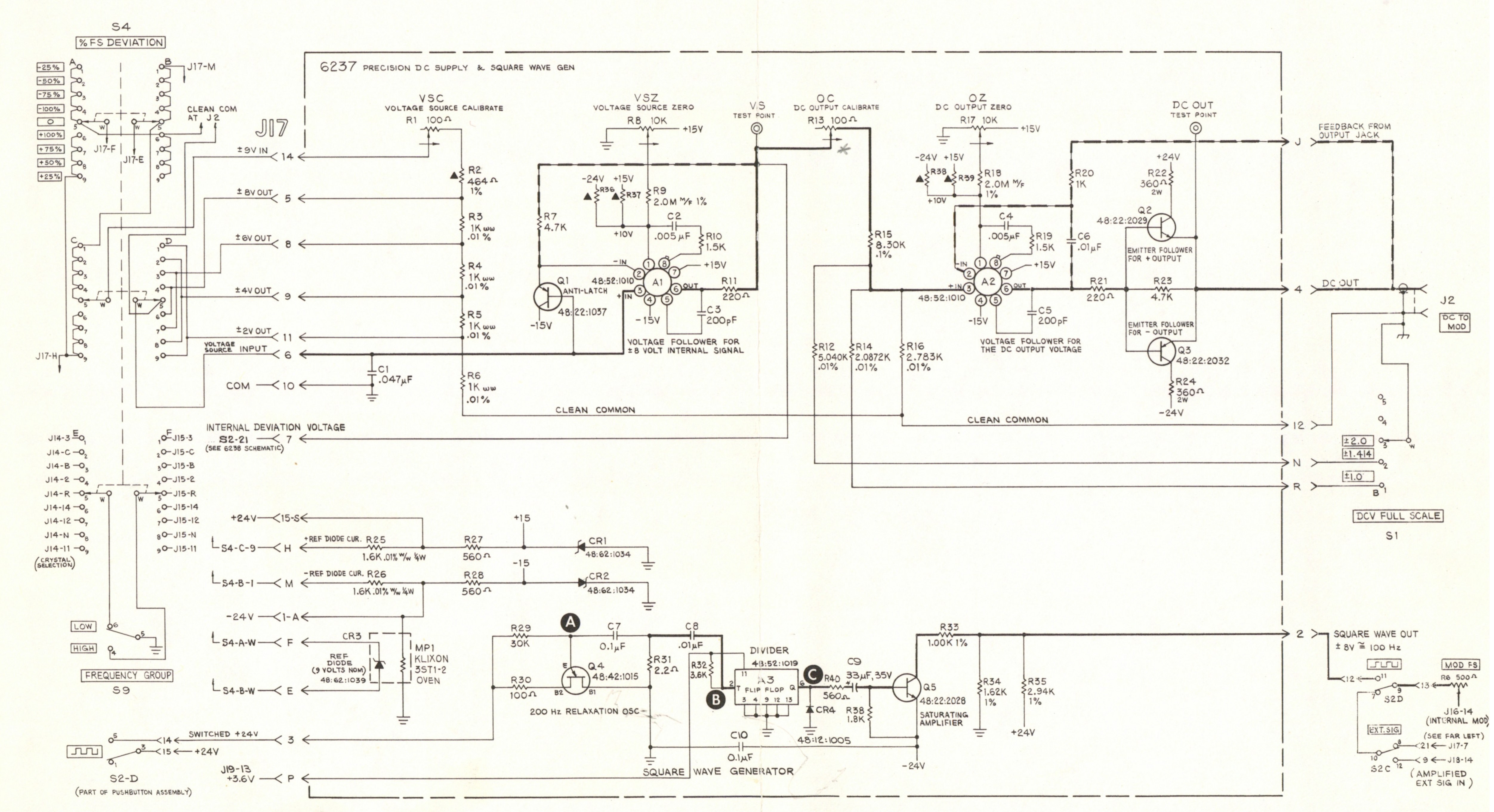
Test Conditions

The frequency shown is 110Hz rather than nominal 100Hz. ⊓⊔ button depressed.









NOTES:

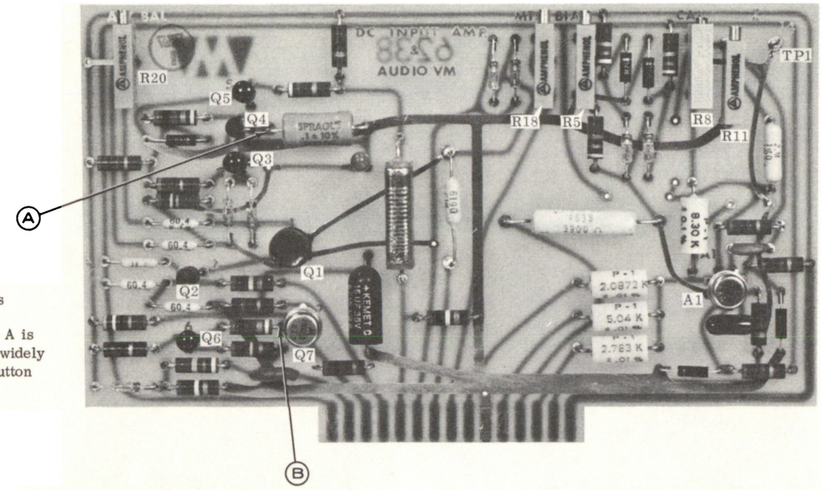
1. — — — — INDICATES CIRCUIT CARD OUTLINE
2. ▲ INDICATES COMPONENT SELECTED IN CALIBRATION. NOMINAL COMPONENT VALUE MAY OR MAY NOT APPEAR IN DIAGRAM.
3. ▭ INDICATES FRONT PANEL MARKING.
4. ——— INDICATES SIGNAL PATH.
5. ━ ━ ━ INDICATES FEEDBACK PATH.
6. ─< ←(SMALL SYMBOL) INDICATES 6232 PIN & SOCKET

* CHANGED TO 500Ω FOR MORE ADJ. RANGE

Figure 6 - 6 Card 6237

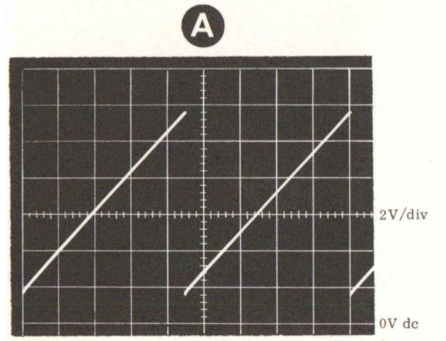
PRECISION D.C. SUPPLY + SQ. WAVE GEN

6238

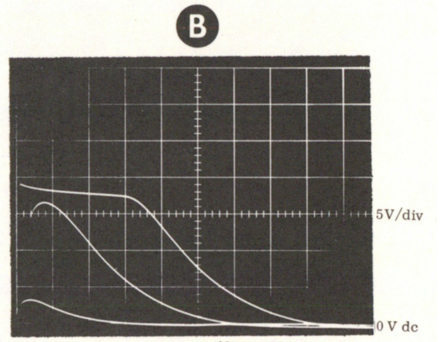


Test Conditions

The frequency shown in A is 220Hz, but it will vary widely depending on DEMOD button depressed.



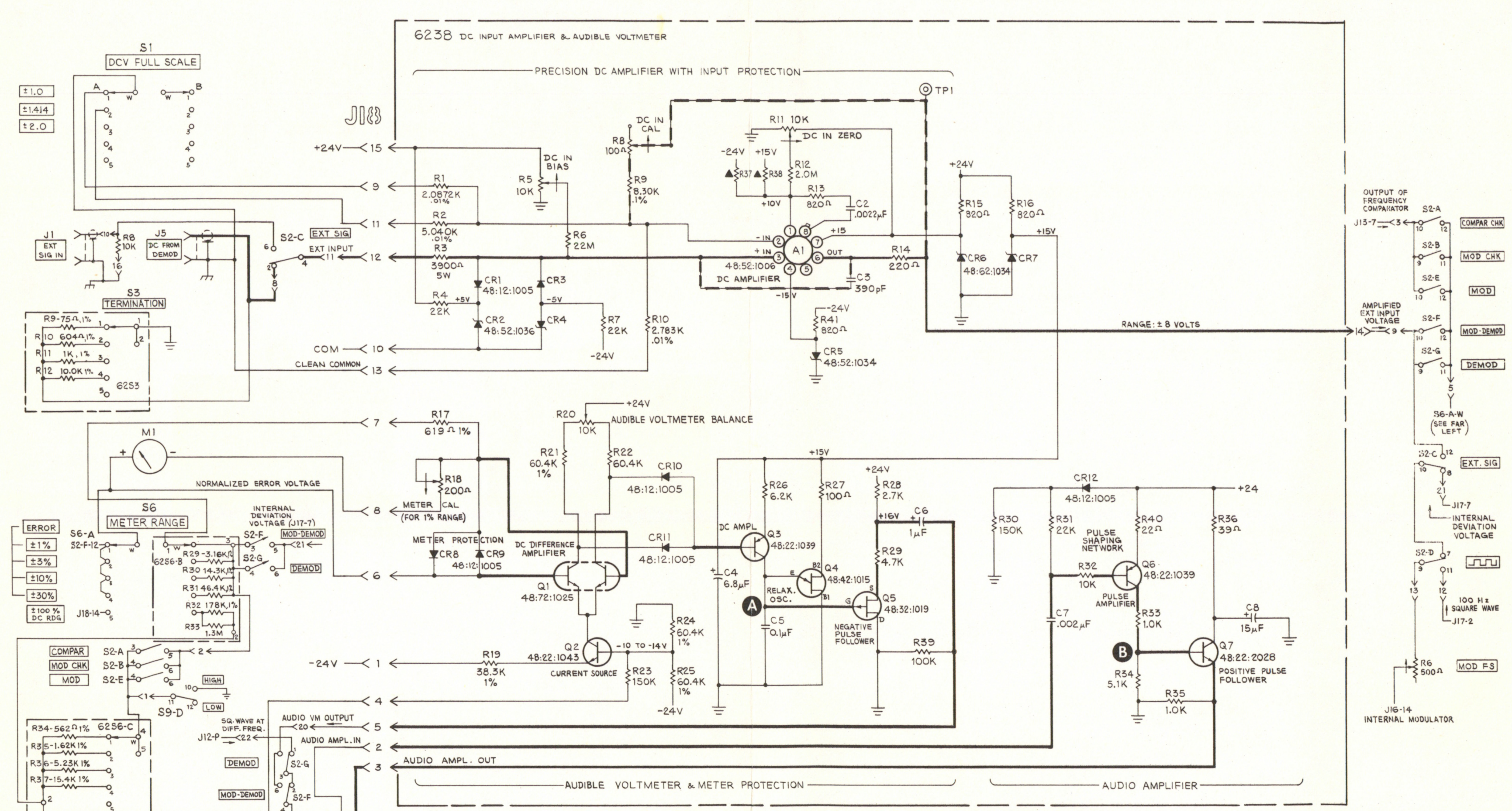
1 msec/div



10 μsec/div

MULTIPLE EXPOSURE

(Low, Med. & High Volume)



NOTES:

1. ------ INDICATES CIRCUIT CARD OUTLINE.

2. ▲ INDICATES COMPONENT SELECTED IN CALIBRATION. PART MAY OR MAY NOT BE REQUIRED; PARTICULARLY R_A AND R_B.

3. ▭ INDICATES FRONT PANEL MARKINGS.

4. ——— INDICATES SIGNAL PATH.

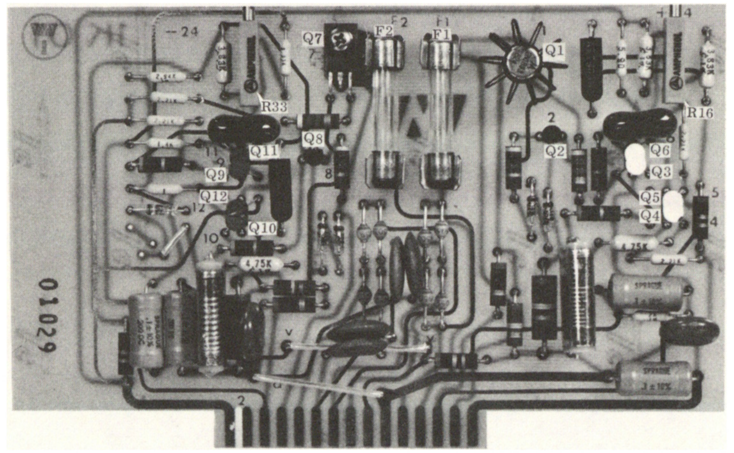
5. ━ ━ ━ INDICATES FEEDBACK PATH.

6. < ←(SMALL SYMBOL) INDICATES 6252 PIN AND SOCKET.

Figure 6 - 7 Card 6238

DC INPUT AMPLIFIER & AUDIBLE VOLTMETER

1K01



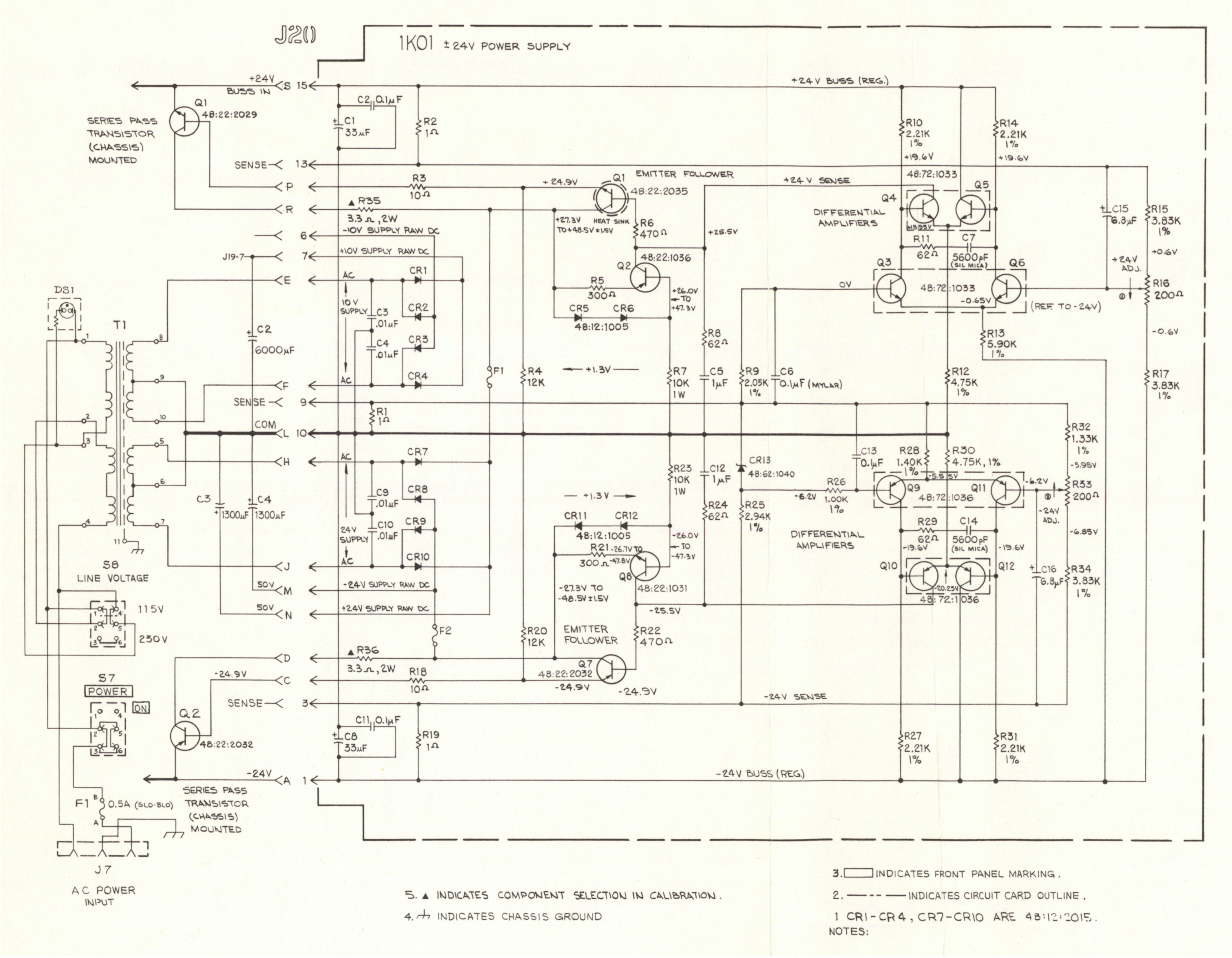
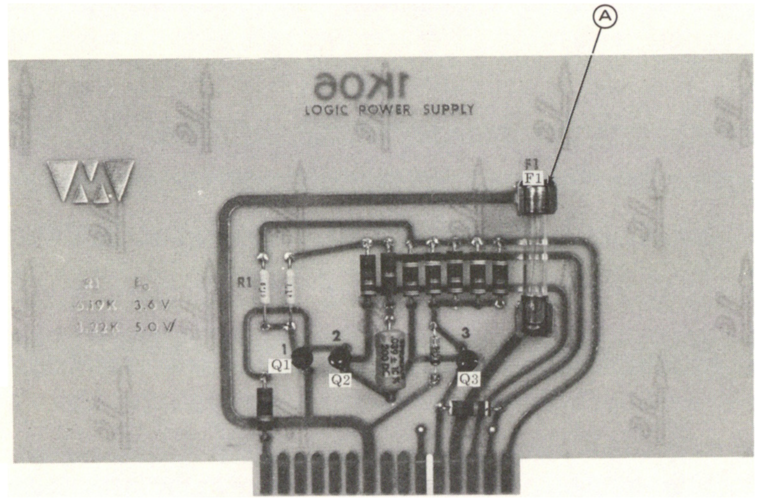


Figure 6 - 8 Card 1K01

±24V POWER SUPPLY

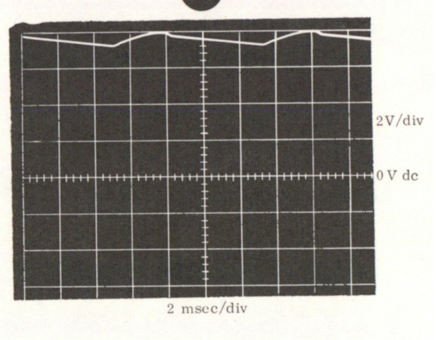
1K06

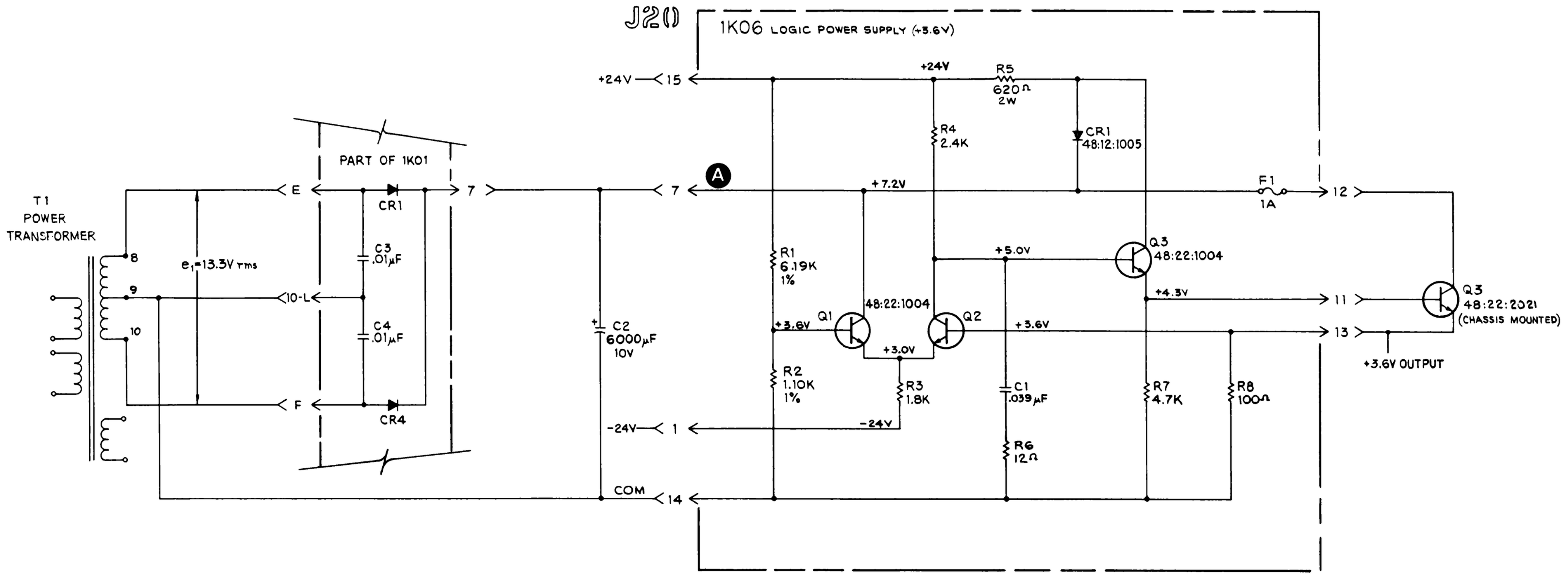


Test Conditions

Normal loading; all cards in place.

A





1. — — — INDICATES CIRCUIT CARD OUTLINE.

NOTES:

Figure 6 - 9 Card 1K06

LOGIC POWER SUPPLY (+3.6V)

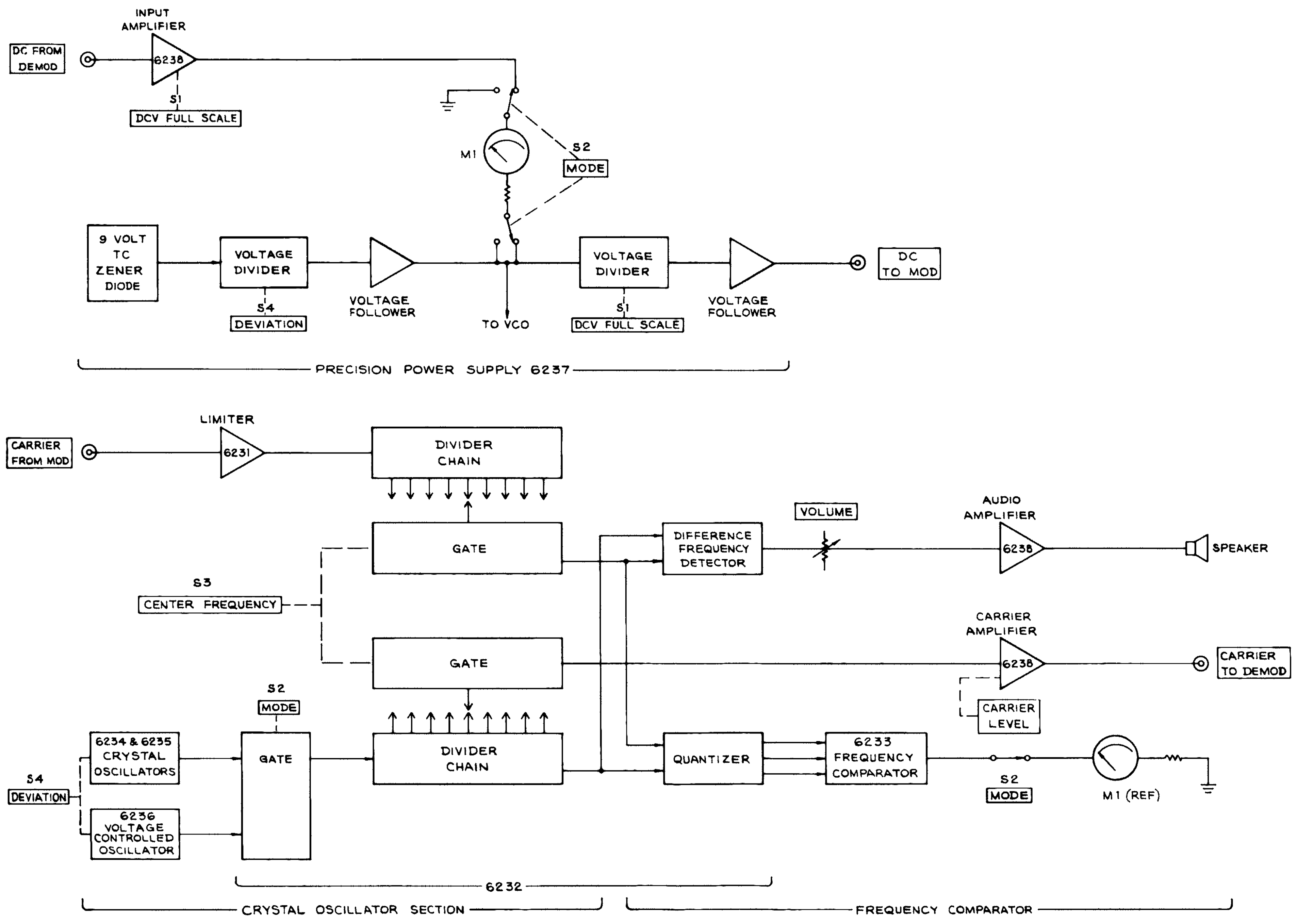


Figure 6 - 10

BLOCK DIAGRAM

SECTION VII

TABLE OF REPLACEABLE PARTS

7-1 This section contains information for ordering replacement parts.

7-2 To obtain replacement parts, address your order to:
Service Department
MICOM, Incorporated
855 Commercial Street
Palo Alto, California 94303

7-3 Specify the following information for each part ordered:

a. Model and complete serial number of the instrument
b. MICOM stock number
c. Circuit reference designator and description

For non-listed parts, include the model and serial numbers, a description of the part, and the function and location of the part.

REFERENCE DESIGNATORS

A	assembly	J	jack	R	resistor
C	capacitor	K	relay	S	switch
CR	diode	L	inductor	T	transformer
DS	lamp	M	meter	V	vacuum tube, photocell, etc.
F	fuse	MP	mechanical part	W	cable
FF	flip-flop	P	plug	Y	crystal
FL	filter	Q	transistor	Z	network

ABBREVIATIONS

A	Ampere	d	10^{-1}	Ge	germanium
dB	deciBel	m	10^{-3}	int cir	integrated circuit
F	Farad	μ	10^{-6}	M/F	metal film
H	Henry	n	10^{-9}	my	mylar
Hz	Hertz (cycle per second)	p	10^{-12}	poly	polystyrene
V	Volt			poly c	polycarbonate
W	Watt	al elect	aluminum electrolytic	Si	silicon
		cer	ceramic	sil mica	silver mica
M	10^6	comp	composition	Ta	tantalum
K	10^3	FET	field effect transistor	var	variable
D	10	fxd	fixed	ww	wirewound

▲ designates component selected in mfg. - may be omitted.

COMPANY ABBREVIATIONS

A	Arco	EM	Electromotive Mfg. Company	S	Sprague
AB	Allen Bradley	F	Fairchild	SC	Switchcraft
ANL	Amphenol	GE	General Electric	SH	Siemens and Halske
B	Bourns	GI	General Instrument	SY	Sylvania
CL	Clarostat	IRC	Internat'l. Resistance Co.	TI	Texas Instruments
CRL	Centralab	KT	Kemet	TRW	Thompson Ramo Woolridge
CTS	CTS Corporation	MO	Motorola	VK	Viking
D	Dialco	RA	Raytheon		
EL	Electra Mfg. Company	RCA	Radio Corporation of America		

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
Card 6231 Limiter			
A1	Integrated Circuit: Quad Gate MO MC824P	48:52:1020	1
A2	Integrated Circuit: Single JK flip-flop MO MC826P	48:52:1019	1
C1	C: fxd: Met My .01μF 200V 20%	15:29:1037	1
C2, C3, C4, C6	C: fxd: Ta 6.8μF 35V 20% KT E Series	15:37:6857	4
C5	C: fxd: Met My 0.47μF 100V	15:49:4747	1
CR1, CR2, CR3, CR4, CR5	Diode: F IN3064	48:12:1005	5
Q1	Transistor: FET P type F 2N4360	48:72:1032	1
Q2, Q3, Q4	Transistor: SI NPN MO 2N4124	48:22:1033	3
R1	R: fxd: Comp 100K 5% ½W	47:22:1045	1
R2, R18	R: fxd: Comp 22K 5% ½W	47:22:2235	2
R3, R5, R7	R: fxd: Comp 100Ω 5% ½W	47:22:1015	3
R4	R: fxd: Comp 10K 5% ½W	47:22:1035	1
R6	R: fxd: Comp 51K 5% ½W	47:22:5135	1
R8, R15, R17	R: fxd: Comp 1K 5% ½W	47:22:1025	3
R9	R: fxd: Comp 18K 5% ½W	47:22:1835	1
R10	R: fxd: Comp 12K 5% ½W	47:22:1235	1
R11	R: fxd: Comp 4.7K 5% ½W	47:22:4725	2
R12, R14	R: fxd: Comp 68K 5% ½W	47:22:6835	1
R13	R: fxd: Comp 13K 5% ½W	47:22:1335	2
R16, R19	R: fxd: Comp 620Ω 5% ½W	47:22:6215	1
R20	R: fxd: Comp 1.5K 5% ½W	47:22:1525	1
R21	R: fxd: Comp 47K 5% ½W	47:22:4735	1
Card 6232 Divider			
A1, A9, A10, A11, A12, A19	Integrated Circuit: Quad Gate MO MC824P	48:52:1020	6
A2, A3, A4, A15, A16, A17, A18	Integrated Circuit: Dual JK flip-flop MO MC890P	48:52:1021	7
A5, A7	Integrated Circuit: Dual JK flip-flop MO MC3062P	48:52:1008	2
A6	Integrated Circuit: Quad Gate MO MC3002P	48:52:1015	1
A8	Integrated Circuit: Single JK flip-flop MO MC826P	48:52:1019	1
A13, A14	Integrated Circuit: Quad Gate expanders MO MC885P	48:52:1040	2
C1, C2, C3	C: fxd: Ta 6.8μF 35V 20% KT E series	15:37:6857	3
C4	C: fxd: Cer 500pF 100V 10%	15:19:5016	1
CR1	Diode: IN5059	48:12:2015	1
CR2	Diode: Zener 5.1V ± 10% IN5231	48:62:1036	1
Q1	Transistor: SI NPN RCA 2N5187	48:22:1002	1
Q2, Q3	Transistor: SI NPN F 2N3565	48:22:1040	2
R1	R: fxd: WW 270Ω 5W 5%	47:36:2715	
R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12	R: fxd: Comp 1.5K 5% ½W	47:22:1525	11
R13, R14	R: fxd: Comp 680Ω 5% ½W	47:22:6815	2
R15, R16	R: fxd: Comp 1.0K 5% ½W	47:22:1025	2
R17, R18	R: fxd: Comp 4.7K 5% ½W	47:22:4725	2

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
Card 6233 Frequency Comparator and Carrier Amplifier			
A1	Integrated Circuit: Dual JK flip-flop MO MC3062P	48:52:1008	1
A2	Integrated Circuit: Operational Amplifier MO MC1709CG	48:52:1010	1
C1, C5, C6	C: fxd: Ta 6.8μF 35V 20% KT "E" Series	15:37:6857	3
C2, C3, C4, C12	C: fxd: Ta 150μF 15V 20% KT "E" Series	15:34:1577	4
C7, C8	C: fxd: Ta 33μF 35V 20% KT "E" Series	15:37:3367	2
C9	C: fxd: Met My .047 400V 20%	15:29:4737	1
C10, C13	C: fxd: Cer .005μF 100V 10%	15:19:5026	2
C11	C: fxd: Cer 200pF 100V 10%	15:19:2016	1
C14, C15	C: fxd: Selected in Manufacturing		
CR1, CR3, CR5	Diode: F IN3064	48:12:1005	3
CR2	Diode: Zener 5.1V ± 10% MO IN5231	48:62:1036	1
CR4, CR6, CR7	Diode: Zener 7.5V ± 10% MO IN5236	48:62:1035	3
CR8	Diode: Zener 15V ± 10% MO IN5245	48:62:1034	1
Q1	Transistor: SI PNP F 2N4250	48:22:1039	1
Q2	Transistor: SI NPN RCA 2N5187	48:22:1002	1
Q3	Transistor: SI NPN F 2N2219	48:22:2030	1
Q4	Transistor: SI PNP F 2N2905	48:22:2015	1
Q5	Transistor: SI NPN MO 2N4922	48:22:2029	1
Q6, Q7, Q8	Transistor: FET N type matched sets SIL 2N4340	48:72:1041	3
Q9	Transistor: SI NPN MO 2N5089	48:22:1043	1
R3, R5, R13	R: fxd: Comp 1.2K 5% $\frac{1}{2}$W	47:22:1225	3
R4, R9, R10	R: fxd: Comp 1.3K 5% 2W	47:24:1325	3
R6	R: fxd: Comp 22K 5% $\frac{1}{2}$W	47:22:2235	1
R7, R25	R: var: WW 10K 1W 15T	47:53:103C	2
R8	R: fxd: Comp 240Ω 5% $\frac{1}{2}$W	47:22:2415	1
R11	R: fxd: Comp 150Ω 5% $\frac{1}{2}$W	47:22:1515	1
R12	R: fxd: Comp 75Ω 5% $\frac{1}{2}$W	47:22:7505	1
R14.	R: fxd: Selected in Manufacturing		1
R15, R20	R: fxd: Comp 2K 5% $\frac{1}{2}$W	47:22:2025	2
R16	R: fxd: M/F 7.87K 1% $\frac{1}{4}$W	47:11:7871	1
R17	R: var: WW 1K 1W 15T	47:53:102C	1
R18	R: fxd: M/F 30.1K 1% $\frac{1}{4}$W	47:11:3012	1
R19	R: fxd: M/F 17.8K 1% $\frac{1}{4}$W	47:11:1782	1
R21, R23	R: fxd: WW 2.0872K .01%	47:31:2087	2
R22	R: fxd: Comp 10MEG 5% $\frac{1}{2}$W	47:22:1065	1
R24, R28	R: fxd: M/F 107K 1% $\frac{1}{4}$W	47:11:1073	2
R26	R: fxd: M/F 2MEG 1% $\frac{1}{4}$W	47:11:2004	1
R27	R: fxd: Comp 1.5K 5% $\frac{1}{2}$W	47:22:1525	1
R29, R30	R: fxd: Comp 510Ω 5% 1W	47:23:5105	2
R31, R32, R33	R: fxd: Selected in Manufacturing		3

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
Card 6234 Crystal Oscillator Low Band			
A1	Integrated Circuit: Single JK flip-flop MO MC826P	48:52:1019	1
C1, C3, C4	C: fxd: Cer .001μF 100V 10%	15:19:1026	3
C2, C5	C: fxd: Cer .01μF 100V 10%	15:19:1036	2
C6	C: fxd: Ta 150μF 15V 20% KT E Series	15:34:1577	1
C7	C: fxd: Sil Mica 33pF 100V 5%	15:49:3305	1
CR1 thru CR22	Diode: F 1N3064	48:12:1005	22
Q1, Q2	Transistor: SI PNP MO MPS6523	48:22:1029	2
Q3, Q4	Transistor: SI NPN RCA 2N5187	48:22:1002	2
R1	R: fxd: Comp 560Ω 5% ½W	47:22:5615	1
R2	R: fxd: Comp 15K 5% ½W	47:22:1535	1
R3	R: fxd: Comp 5.1K 5% ½W	47:22:5125	1
R4, R5	R: fxd: Comp 1K 5% ½W	47:22:1025	2
R6, R8	R: fxd: Comp 1MEG 5% ½W	47:22:1055	2
R7	R: fxd: Comp 620Ω 5% ½W	47:22:6215	1
R9	Not used on this card		
R10	R: fxd: Comp 6.8Ω 5% ½W	47:22:0685	1
R11, R13, R15, R17, R19, R21, R23, R25, R27	R: fxd: Comp 360Ω 5% ½W	47:22:3615	9
R12, R14, R16, R18, R20, R22, R24, R26, R28	R: fxd: Comp 3.0K 5% ½W	47:22:3025	9
Y1	Crystal Quartz 3.11040MHz	61:01:3116	1
Y2	Crystal Quartz 2.76480MHz	61:01:2766	1
Y3	Crystal Quartz 2.41920MHz	61:01:2416	1
Y4	Crystal Quartz 2.07360MHz	61:01:2076	1
Y5	Crystal Quartz 3.45600MHz	61:01:3456	1
Y6	Crystal Quartz 4.83840MHz	61:01:4836	1
Y7	Crystal Quartz 4.49280MHz	61:01:4496	1
Y8	Crystal Quartz 4.14720MHz	61:01:4147	1
Y9	Crystal Quartz 3.80160MHz	61:01:3806	1
Card 6235 Crystal Oscillator High Band (Same as Card 6234, except for the following)			
R9	R: fxd: Comp 270Ω 5% ½W	47:22:2715	1
Y1	Crystal Quartz 3.33000MHz	61:01:3336	1
Y2	Crystal Quartz 3.06000MHz	61:01:3066	1
Y3	Crystal Quartz 2.79000MHz	61:01:2796	1
Y4	Crystal Quartz 2.52000MHz	61:01:2526	1
Y5	Crystal Quartz 3.60000MHz	61:01:3606	1
Y6	Crystal Quartz 4.68000MHz	61:01:4686	1
Y7	Crystal Quartz 4.41000MHz	61:01:4416	1
Y8	Crystal Quartz 4.14000MHz	61:01:4146	1
Y9	Crystal Quartz 3.87000MHz	61:01:3876	1

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
Card 6237 Precision DC Supply and Square Wave Generator			
A1, A2	Integrated Circuit:Operational Amplifier MO MC1709CG	48:52:1010	2
A3	Integrated Circuit: Single JK flip-flop MO MC826P	48:52:1019	1
C1	C: fxd: Met My .047µF 400V 20%	15:29:4737	1
C2, C4	C: fxd: Cer .005µF 100V 10%	15:19:5026	2
C3, C5	C: fxd: Cer 200pF 100V 10%	15:19:2016	2
C8	C: fxd: Cer .01µF 100V 10%	15:19:1036	1
C7, C10	C: fxd: Met My 0.1µF 200V 10%	15:29:1046	2
C9	C: fxd: Ta 33uF 35V 20% KT "E" Series	15:37:3367	1
C6	C: fxd: Met My .01uF 200V 10%	15:29:1036	1
CR1, CR2	Diode: Zener 15V ± 10% MO IN5245	48:62:1034	2
CR3	Diode: Zener 9V + 5% TC MO IN938A	48:62:1039	1
CR4	Diode: Si F IN3064	48:12:1005	1
MP1	Oven: +75°C, 24V Klixon 3STI-2	18:50:0001	1
Q1	Transistor: SI PNP F 2N5138	48:22:1037	1
Q2	Transistor: SI NPN MO 2N4922	48:22:2029	1
Q3	Transistor: SI PNP MO 2N4919	48:22:2032	1
Q4	Transistor: Unijunction MO 2N4871	48:42:1015	1
Q5	Transistor: SI NPN RCA 2N3053	48:22:2028	1
R1, R13	R: var: Cer 100Ω 1W Heli 79PR100	47:53:101C	2
R2	R: fxd: M/F Selected in Manufacturing		1
R3, R4, R5, R6	R: fxd: WW 1K .01%	47:31:1000	4
R7, R23	R: fxd: Comp 4.7K 5% ½W	47:22:4725	2
R8, R17	R: var: WW 10K 1W 15T	47:53:103C	2
R9, R18	R: fxd: M/F 2.0MEG 1% ¼W	47:11:2004	2
R10, R19	R: fxd: Comp 1.5K 5% ½W	47:22:1525	2
R11, R21	R: fxd: Comp 220Ω 5% ½W	47:22:2215	2
R12	R: fxd: WW 5.04K .01% ¼W	47:31:5040	1
R14	R: fxd: WW 2.0872K .01% ¼W	47:31:2087	1
R15	R: fxd: WW 8.30K 0.1%	47:31:8300	1
R16	R: fxd: WW 2.783K .01% ¼W	47:31:2783	1
R20	R: fxd: Comp 1K 5% ½W	47:22:1025	1
R22, R24	R: fxd: Comp 360Ω 5% 2W	47:24:3615	2
R25, R26	R: fxd: WW 1.60K .01% ¼W	47:31:1601	2
R27, R28, R40	R: fxd: Comp560Ω 5% ½W	47:22:5615	3
R29	R: fxd: Comp 30K 5% ½W	47:22:3035	1
R30	R: fxd: Comp 100 Ω 5% ½W	47:22:1015	1
R31	R: fxd: Comp 2.2Ω 5% ½W	47:22:0225	1
R32	R: fxd: Comp 3.6K 5% ½W	47:22:3625	1
R33	R: fxd: M/F 1.0K 1% ¼W	47:11:1001	1
R34	R: fxd: M/F 1.62K 1% ¼W	47:11:1621	1
R35	R: fxd: M/F 2.94K 1% ¼W	47:11:2941	1
R36	R: fxd: Comp 1.8K 5% ½W	47:22:1825	1

Table 7-1. Replaceable Parts (Cont'd).

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
Card 6238 DC Input Amplifier and Audible Voltmeter			
A1	Integrated Circuit: Operational Amplifier, Burr-Brown 3057	48:52:1006	1
C2	C: fxd: Cer .0022 μF 100V 10%	15:19:2226	1
C3	C: fxd: Sil Mica 390pF 100V 5%	15:49:3915	1
C4	C: fxd: Ta 6.8μF 35V 20% KT E Series	15:37:6857	1
C5	C: fxd: Met My 0.1μF 200V 10%	15:29:1046	1
C6	C: fxd: Met My 1.0μF 250V 10%	15:29:1057	1
C7	C: fxd: Cer .002μF 100V 10%	15:19:2026	1
C8	C: fxd: Ta 15μF 35V 20% C Series	15:35:1567	1
CR1, CR3, CR8, CR9, CR10, CR11, CR12	Diode: F IN3064	48:12:1005	7
CR2, CR4	Diode: Zener 5.1V ± 10% MO IN5231	48:62:1036	2
CR5, CR6, CR7	Diode: Zener 15V ± 10% MO IN5245	48:62:1034	3
Q1	Transistor: Dual SI NPN S TD-101	48:72:1025	1
Q2	Transistor: SI NPN MO 2N5089	48:22:1043	1
Q3, Q6	Transistor: SI PNP F 2N4250	48:22:1039	2
Q4	Transistor: Unijunction MO 2N4871	48:42:1015	1
Q5	Transistor: FET P-Channel F 2N4360	48:32:1019	1
Q7	Transistor: SI NPN RCA 2N3053	48:22:2028	1
R1	R: fxd: WW 2.0872K .01%	47:31:2087	
R2	R: fxd: WW 5.040K .01%	47:31:5040	
R3	R: fxd: WW 3.9K 5% 5W	47:36:3925	. 1
R4, R7, R31	R: fxd: Comp 22K 5% ½W	47:22:2235	3
R5, R11, R20	R: var: WW 10K 1W 15T	47:53:103C	3
R6	R: fxd: Comp 22MEG 5% ½W	47:22:2265	1
R8	R: var: Cer 100Ω 1W 15T Heli 79PR100	47:53:101C	1
R9	R: fxd: WW 8.30K 0.1%	47:11:8301	1
R10	R: fxd: WW 2.783K .01%	47:31:2783	1
R12	R: fxd: M/F 2.0Meg 1% ¼W	47:11:2004	1
R13, R15, R16, R41	R: fxd: Comp 820Ω 5% ½W	47:22:8215	4
R14	R: fxd: Comp 220Ω 5% ½W	47:22:2215	1
R17	R: fxd: M/F 619Ω 1% ¼W	47:11:6190	1
R18	R: var: WW 200Ω 1W 15T	47:53:201C	1
R19	R: fxd: M/F 38.3K 1% ¼W	47:11:3832	1
R21, R22, R24, R25	R: fxd: M/F 60.4K 1% ¼W	47:11:6042	4
R23, R30	R: fxd: Comp 150K 5% ½W	47:22:1545	2
R26	R: fxd: Comp 6.2K 5% ½W	47:22:6225	1
R27	R: fxd: Comp 100Ω 5% ½W	47:22:1015	1
R28	R: fxd: Comp 2.7K 5% ½W	47:22:2725	1
R29	R: fxd: Comp 4.7K 5% ½W	47:22:4725	1
R32	R: fxd: Comp 10K 5% ½W	47:22:1035	1
R33, R35	R: fxd: Comp 1K 5% ½W	47:22:1025	2
R34	R: fxd: Comp 5.1K 5% ½W	47:22:5125	1
R36	R: fxd: Comp 39Ω 5% ½W	47:22:3905	1
R37, R38	R: fxd: M/F Selected in Manufacturing		2
R39	R: fxd: Comp 100K 5% ½W	47:22:1045	1
R40	R: fxd: Comp 22Ω 5% ½W	47:22:2205	1

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
1K06 Logic Power Supply +3.6V			
C1	C: fxd: Met My .039μF 200V 10%	15:29:3936	1
CR1	Diode: F IN3064	48:12:1005	1
F1	Fuse: 3AG, Reg. 1Amp 250V	51:23:0100	1
Q1, Q2, Q3	Transistor: SI NPN GE 2N2925	48:22:1004	3
R1	R: fxd: M/F 6.19K 1% ¼W	47:11:6191	1
R2	R: fxd: M/F 1.10K 1% ¼W	47:11:1101	1
R3	R: fxd: Comp 1.8K 5% ½W	47:22:1825	1
R4	R: fxd: Comp 2.4K 5% ½W	47:22:2425	1
R5	R: fxd: Comp 620Ω 5% 2W (May be 4 - 2.4K 5% ½W in Parallel)	47:24:6215	1
R6	R: fxd: Comp 12Ω 5% ½W	47:22:1205	1
R7	R: fxd: Comp 4.7K 5% ½W	47:22:4725	1
R8	R: fxd: Comp 100Ω 5% ½W	47:22:1015	1
1K01 ±24V Supply			
C1, C8	C: fxd: Ta 33μF 35V 20% KT E Series	15:37:3367	2
C2, C6, C11, C13	C: fxd: Met My 0.1μF 200 V 10% Sprague	15:29:1046	4
C3, C4, C9, C10	C: fxd: Cer .01μF 100V 10% TRW	15:19:1036	4
C5, C12	C: fxd: Mt My 1.0μF 250V 20%	15:29:1057	2
C7, C14	C: fxd: Sil Mica 5600pF 5%	15:49:5625	2
C15, C16	C: fxd: Ta 6.8μF 35V 20% KT E Series	15:37:6857	2
CR1, CR2, CR3, CR4, CR7, CR8, CR9, CR10	Diode: IN5059 SI GE	48:12:2015	8
CR5, CR6, CR11, CR12	Diode: IN3064 SI F	48:12:1005	4
CR14	Diode: Zener IN823A	48:62:1040	1
F1, F2	Fuse: ½A 3AG Reg	51:23:0050	2
R1, R2, R19	R: fxd: Comp 1Ω 5% ½W	47:22:0105	3
R3, R18	R: fxd: Comp 10Ω 5% ½W	47:22:1005	2
R4, R20	R: fxd: Comp 12K 5% ½W	47:22:1235	2
R5, R21	R: fxd: Comp 300Ω 5% ½W	47:22:3015	2
R6, R22	R: fxd: Comp 470Ω 5% ½W	47:22:4715	2
R7, R23	R: fxd: Comp 10K 5% 1W	47:23:1035	
R8, R11, R24, R29	R: fxd: Comp 62Ω 5% ½W	47:22:6205	4
R9	R: fxd: M/F 2K 1% ¼W	47:11:2001	1
R10, R14, R27, R31	R: fxd: M/F 2.21K 1% ¼W	47:11:2211	4
R12, R30	R: fxd: M/F 4.75K 1% ½W	47:11:4751	2
R13	R: fxd: M/F 5.90K 1% ¼W	47:11:5901	1
R15, R17, R34	R: fxd: M/F 3.83K 1% ¼W	47:11:3831	3
R16, R33	R: var: WW 200Ω 15T 1W	47:53:201C	2
Q1	Transistor: SI NPN 2N1893 MO	48:22:2035	1
Q2	Transistor: SI PNP 2N4125 MO	48:22:1036	1
(Q3, Q6) (Q4, Q5)	Transistor: SI NPN Matched MO 2N4123	48:72:1033	2 pr.
Q7	Transistor: SI PNP 2N4919 MO	48:22:2032	1
Q8	Transistor: SI NPN 2N4123 MO	48:22:1031	1
(Q9, Q11) (Q10, Q12)	Transistor: SI PNP Matched MO 2N4125	48:72:1036	2 pr.

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
CHASSIS COMPONENTS			
C2	C: fxd: Alum. Elec. 6000μF 10V	15:73:6088	1
C3, C4	C: fxd: Alum. Elec. 1300μF 50V	15:78:1388	2
F1	Fuse: 3AG Slo Blo ½Amp 250V	51:22:0050	1
	Fuse Holder: 3AG	21:27:1700	1
J7	Connector: AC 3Pin male power AC3G	21:14:0603	1
J11,J16,J18,J19	Connector: 15Pin P.C. single sided 2VK15S/1-2	21:21:0815	4
J12,J13,J14,J15,J17,J20	Connector: 15Pin P.C. double sided 2VK15/1AN-2	21:21:0915	6
Q1	Transistor: SI NPN MO 2N4922	48:22:2029	1
Q2	Transistor: SI PNP MO 2N4919	48:22:2032	1
Q3	Transistor: SI NPN MO 2N5190	48:22:2021	1
S8	Switch: Slide, 2P2T 115-230V	51:22:0301	1
T1	Transformer: Power 115-230V Pri 14-M-13	56:11:1251	1
FRONT PANEL COMPONENTS			
DS1	Lamp: Neon 115VAC	39:63:1200	1
J1, J2, J3, J4, J5	Connector: BNC UG 657/U	21:25:0700	5
J6	Connector: (phone type)	21:13:0300	1
	With Knurled Nut	28:63:3745	
M1	Meter: 50-0-50 μA DC 4"	29:31:6200	1
R1	R: CARRIER LEVEL Var. Comp. 10K 2W Linear	47:24:103A	1
R2	R: VOLUME ADJ. Var. Comp. 10K 2W Log	47:74:103A	1
R3	R: RATE ADJ. Var. Comp. 10K 2W Linear	47:24:103A	1
R4	R: COMPARATOR ZERO Var. WW 10K 2W CL43C2	47:34:103C	1
R5	R: MOD ZERO Var. WW 10K 2W CL43C2	47:34:103C	1
R6	R: MOD FULL SCALE Var. WW 500 ohm 2W Cl43C2	47:34:501C	1
R7	R: fxd: M/F 20K 1% ¼W (mounted on R5	47:11:2002	1
SP1	Speaker: 2½" 100Ω 200 MW	24:01:0001	1
S1	Switch: DCV FULL SCALE 2 Pol. 3 Pos. CTS#59510	51:42:0533	1
S2	Switch: MODE 7 section of 4P2T CRL	51:34:0726	1
	With the following parts on P.C. Board 62S2		
	R8 R: fxd: Comp 10K 5% ½W 47:22:1035		
S3	Switch: TERMINATION 1 Pol. 5 Pos. CTS#59529	51:41:0536	1
	With the following parts on P.C. Board 62S3		
	R9 R: fxd:M/F 75Ω 1% ¼W 47:11:0075		
	R10 R: fxd: M/F 604Ω 1% ¼W 47:11:0604		
	R11 R: fxd: M/F 1.0K 1% ¼W 47:11:1001		
	R12 R: fxd: M/F 10.0K 1% ¼W 47:11:1002		

Table 7-1. Replaceable Parts (Cont'd.)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
FRONT PANEL COMPONENTS CONTINUED			
S4	Switch: DEVIATION 8 Pol. 9 Pos. CTS#59667 With the following parts on P.C. Board 62S4:	51:48:0937	1
	R13 R: fxd: M/F 237K 1% ¼W 47:11:2373		
	R14 R: fxd: M/F 115K 1% ¼W 47:11:1153		
	R15 R: fxd: M/F 75.0K 1% ¼W 47:11:7502		
	R16, R23 R: fxd: M/F 51.1K 1% ¼W 47:11:5112		
	R17, R26 R: fxd: M/F 26.1K 1% ¼W 47:11:2612		
	R18 R: fxd: M/F 38.3K 1% ¼W 47:11:3832		
	R19 R: fxd: M/F 64.9K 1% ¼W 47:11:6492		
	R20 R: fxd: M/F 137K 1% ¼W 47:11:1373		
	R21 R: fxd: M/F 178K 1% ¼W 47:11:1783		
	R22 R: fxd: M/F 82.5K 1% ¼W 47:11:8252		
	R24 R: fxd: M/F 36.5K 1% ¼W 47:11:3652		
	R25 R: fxd: M/F 16.9K 1% ¼W 47:11:1692		
	R27 R: fxd: M/F 44.2K 1% ¼W 47:11:4422		
	R28 R: fxd: M/F 100K 1% ¼W 47:11:1003		
S5	Switch: CENTER FREQ. 1 Pol. 9 Pos. CTS#59511	51:41:0934	1
S6	Switch: METER RANGE 3 Pol. 5 Pos. CTS#59530 With the following parts on P.C. Board 62S6:	51:43:1035	1
	R29 R: fxd: M/F 3.16K 1% ¼W 47:11:3161		
	R30 R: fxd: M/F 14.3K 1% ¼W 47:11:1432		
	R31 R: fxd: M/F 46.4K 1% ¼W 47:11:4642		
	R32 R: fxd: M/F 178K 1% ¼W 47:11:1783		
	R33 R: fxd: Comp 1.3MEG 5% ½W 47:22:1355		
	R34 R: fxd: M/F 562Ω 1% ¼W 47:11:5620		
	R35 R: fxd: M/F 1.62K 1% ¼W 47:11:1621		
	R36 R: fxd: M/F 5.23K 1% ¼W 47:11:5231		
	R37 R: fxd: M/F 15.4K 47:11:1542		
S7	Switch: POWER ON, Slide Rocker 2PIT	51:52:0202	1
S9	Switch: FREQ. GROUP, Slide Stackpole 5P2T	51:25:0530	1
MISCELLANEOUS COMPONENTS			
	Casting Inner Left & Right	14:60:0003	2
	Casting Outer Left	14:12:0014	1
	Casting Outer Right	14:12:0015	1
	Clip: #4 Tinnerman C7795-44027	28:72:7601	23
	Clip: #6 Tinnerman C6452-632	28:72:7602	16
	Cover: Top	14:11:0003	1
	Cover: Bottom	14:11:0003	1
	Feet: Rubber	28:87:0001	4
	Knob: Skirted Round	24:22:0015	1
	Knob: Skirted Bar	24:22:0010	5
	Knob: Round, White Dot	24:22:0017	2
	Knob: Push Button Grey	24:22:0021	5
	Knob: Push Button Black	24:22:0022	2
	Meter Bezel	14:13:0001	1
	Speaker Grill 1"	28:50:0656	1
	Panel Front	24:11:6200	
	Handles	24:31:0001	
	Screws: Rack Mounting 10-32 x 2"	28:11:2118	4
	Screws: Side Casting Mounting #8 x 1¼"	28:12:4814	2
	Screws: Cover Mounting 6-32 x 3/8" F.H.	28:11:3604	12
	Screws: Front Panel Mounting 6-32 x 5/8" F.H.	28:11:3608	4
	Power Cord: Type SVT 8' Belden 17258-#	60:52:0018	1

OPERATING and SERVICE INSTRUCTIONS

VOLTAGE-CONTROLLED OSCILLATOR OPTION (-01)

(Card 6236)

1. GENERAL INFORMATION

1-1 DESCRIPTION

The voltage-controlled oscillator card provides signals for dynamic signal testing. The modulating signal is either an internal squarewave of approximately 100 Hz, or an external voltage applied to the EXT SIG IN jack. A signal modulated by a squarewave should produce a squarewave output from the demodulator under test. If there is a "damping" control or "high frequency response" adjustment on the demodulator, it may be adjusted for the desired response.

If some other type of modulation is desired, you must supply a modulating voltage with an amplitude corresponding to the setting of the DCV FULL SCALE control. The response extends from DC to 20 kHz. There is a convenient self check of the VCO frequency at each of the nine static deviations provided by the crystals.

1-2 SPECIFICATIONS

A. Square Wave Modulation:

1. Amplitude: ±100%, ±5%, full-scale deviation
2. Frequency: 100 Hz, ±25%
3. Risetime: less than 16 microseconds, 10% to 90%.

B. External Signal Modulation:

1. EXT SIG IN impedance: 10K, ±15%.
2. Modulation sensitivity: ±1.0 voltage, ±1.414 and ±2.0 volts for full-scale deviation, depending on the setting of the DCV FULL SCALE control.
3. Frequency response: DC to 20 kHz ±1dB.
4. Risetime: less than 16 micro seconds, 10% to 90%.
5. Linearity: best adjustment shall be within ±1% of peak-to-peak deviation.

2. INSTALLATION

Card 6236 can be installed in any Model 6200 FM Calibrator. Normally, the option is supplied with a new instrument when specified and the instrument is designated a Model 6200-01. The modification consists of inserting Card 6236, with the power off, into socket J16 and going through the calibration procedure below. This does not require outside test instruments.

3. OPERATING INSTRUCTIONS

3-1 To produce a squarewave modulated carrier:

A. Select the desired center frequency by using the CENTER FREQUENCY and FREQUENCY GROUP controls.

B. Push the button marked with a squarewave symbol.

C. Select the desired carrier amplitude by use of the CARRIER LEVEL control.

3-2 To produce an externally modulated carrier:

A. Push the button marked EXT SIG.

B. Set the CARRIER LEVEL control for the desired amplitude.

C. Set the desired modulation sensitivity with the DCV FULL SCALE control.

D. Set the FREQUENCY GROUP switch for the desired band.

E. To use the output, turn the METER RANGE switch to 100% (for standby) and set the CENTER FREQUENCY control to the desired position.

F. If you wish to check the accuracy of the VCO, push the MOD: INTERNAL CAL button, turn the CENTER FREQUENCY control to the highest frequency, the METER RANGE switch to 3% or 1%, and note the error on the meter at each setting of the DEVIATION control. (See

below for calibration procedure). The carrier output at this time is derived from the VCO, so it could also be checked with a counter. To return it to use, push the EXT SIG button and re-select the center frequency.

4. PRINCIPLES OF OPERATION

4-1 GENERAL DESCRIPTION

The card contains a pair of variable pots for gain adjust, a voltage follower, an emitter-coupled multivibrator and an output amplifier.

4-2 SCHEMATIC THEORY

The input signal, which has been amplified up to 8 volts full scale, is attenuated by R22, R21, and R20 to produce the required modulating voltage at J16, pin 11. This voltage is passed through the follower circuit containing Q1 and Q2 and is applied to the bases of Q8 and Q9.

Q10, R29, CR6, and R30 provide a low impedance source of -15 volts, at the Q10 emitter. Both Q8 and R27, Q9 and R28 act as constant current sources whose value depends on the input voltage. These currents charge the timing capacitors C6, C7, C8 and in low band C9, C10, & C11 in addition. The charging current is one factor determining the frequency of oscillation.

The bases of Q6 and Q7 are biased at approximately +12 volts by R6, R8, R13, and R14. The multivibrator action is this:

a) when Q5 and Q7 switch on, the negative step at Q7 collector passes through C4 to Q6 base.

b) Q6 and Q4 then regeneratively turn off, Q6 collector changing from being clamped by CR4 to being clamped by CR2. Q6 base is then quiescent at the level determined by R6 and R8.

c) the positive step at Q7 emitter passes through the timing capacitors C6 through C8 or C11 to Q6 emitter, which also tends to turn off Q6.

d) the negative charging current from Q8 then produces a negative-going ramp at Q6 emitter, which lasts until the Q6 emitter is far enough below the base to the base to start conduction. See waveform A.

e) as Q6 starts to conduct, its collector starts negative; --this turns on Q4 and also turns off Q7; Q4 and Q6 regeneratively turn on, Q7 and A5 regeneratively turn off. The half cycle then repeats with the situations reversed.

The amplitude of the ramp depends on the voltage step at the Q6 or Q7 base, which depends on the current coming from Q3. See waveform 3. The front panel MOD ZERO control produces a fine adjustment of the operating point of Q3 and therefore is also a factor in determining frequency. The selected capacitors (C7 and C10) and the trimmers allow setting for the center frequency while the MOD ZERO control is at its center position. Slight drifts in frequency can then be corrected by the front panel control.

Q11 and Q12 provide a non-saturating output amplifier with a gain of two and a DC shift so the output squarewave is compatible with the RTL gate in the divider card 6232.

The 33-ohm resistors and ferrite beads are of course anti-parasitic devices. CR1 temperature compensates for the V_{BE} of Q3; CR6 compensates for Q10; Q1 compensates for Q8 and Q9.

Note that the output frequency is twice the highest carrier frequency, matching the output of the crystal oscillator. It is halved by the flip-flop in the carrier amplifier on 6233 to obtain best symmetry.

5. MAINTENANCE AND CALIBRATION PROCEDURES

Note that there will be a shift in center frequency when Card 6236 is put on the extender card, so calibration must be done with the card in place.

5-1 CALIBRATION

A. Trim is accomplished by the following sequence:

1) Select the FREQUENCY GROUP desired

2) Turn CENTER FREQUENCY to the highest valve

3) Push MOD: INTERNAL CAL, a grey button

4) Set METER RANGE to ±1%.

5) Set DEVIATION at 0 and adjust the MOD ZERO pot on the front panel, for zero error. This is a screw-drive adjustment.

6) Set DEVIATION alternately to +100% and -100% and adjust the MOD FS pot for the best compromise on error. This is a front panel screwdriver adjustment. In some cases, the overall accuracy may be improved if a full nin-point calibration is made. The MOD FS pot adjustment should be the compromise resulting in best overall linearity.

B. The full calibration procedure is this:

1) Remove the top cover of the instrument.

2) Allow a ten-minute warmup. Leave Card 6236 in its socket.

3) During the warm-up period, you may set the MOD ZERO and MOD FS pots approximately to mid-position.

4) Set FREQUENCY GROUP to HIGH.

5) Set CENTER FREQUENCY to 900 kHz, and

6) Push the MOD: INTERNAL CAL button. After warm up,

7) Set METER RANGE as required to be on scale.

8) Adjust the HI air trimmer capacitor on Card 6236 (near the dual transistor) for zero error. Note that a screwdriver affects the reading, so the final reading is done with the screwdriver removed.

9) Change FREQUENCY GROUP to LOW; adjusts to LO airtrimmer capacitor for zero error.

10) Change DEVIATION to ±100%. Adjust the LO pot on Card 6236 for zero error.

11) Make a final adjustment of the LO pot, which is a compromise on error at ±100% deviations, or at all nine deviations.

12) Change FREQUENCY GROUP to HIGH; adjust the HI pot on Card 6236 for zero error at ±100%.

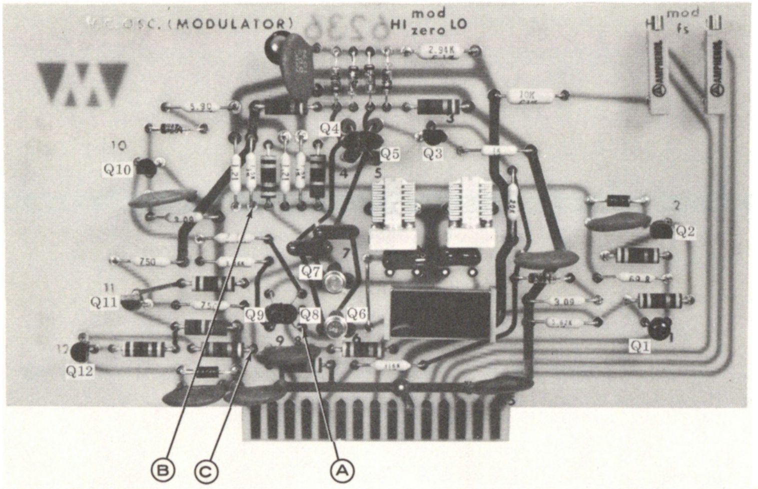
13) Again, make a final adjustment of the HI pot, which is a compromise on error at ±100% deviations, or at all nine deviations.

5-2 TROUBLESHOOTING

First check the two input voltages at Q1 base and R1 since the pots, switches, and card sockets are more apt to fail than the other components. Check that the air trimmers are not shorted. If the output is a large DC voltage, the input gate A1 on Card 6232 may have been damaged.

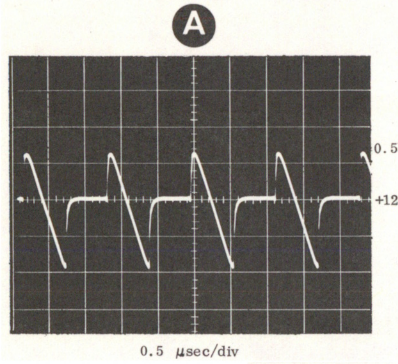
SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	MICOM STOCK NO.	TQ
Card 6236	Voltage Controlled Oscillator (Modulator) OPTION - 01		
C1, C2, C12, C13, C14, C16	C: fxd: Cer .01μF 100V 10%	15:19:1036	6
C3, C15	C: fxd: Cer .005μF 100V 10%	15:19:5026	2
C4, C5	C: fxd: Sil Mica 33pF 100V 5%	15:49:3305	2
C6, C9	C: fxd: VAR AIR 1.8-16.7pF E.F. Johnson 189-506-105	15:99:161A	2
C7, C10	C: fxd: Sil Mica Selected in Manufacturing		2
C8	C: fxd: Sil Mica 300pF 100V 5%	15:49:3015	1
C11	C: fxd: Sil Mica 330pF 100V 5%	15:49:3315	1
CR1, CR6	Diode: F IN3064	48:12:1005	2
(CR2, CR3) (CR4, CR5)	Diode: Matched F IN3064	48:72:1035	2 pr.
CR7	Diode: Zener 13V ± 10% MO IN4743	48:62:1041	1
CR8	Diode: Zener 6.3V ± 5% Selected 2N3638	48:72:1017	1
CR9	Diode: Zener 18V ± 10% MO IN4746	48:62:1042	1
K1	Relay: 1 form A reed 24V Compac 15-1A-24	45:11:0700	1
Q1	Transistor: SI PNP F 2N4250	48:22:1039	1
Q2, Q12	Transistor: SI NPN MO MPS2925	48:22:1024	2
Q3, Q10, Q11	Transistor: SI PNP MO MPS6523	48:22:1029	2
Q4, Q5	Transistor: SI PNP Matched MO MPS6523	48:72:1029	1 pr.
Q6, Q7	Transistor: SI NPN Matched RCA 2N5187	48:72:1002	1 pr.
Q8, Q9	Transistor: SI NPN Matched MO MPS2925	48:72:1024	1 pr.
R1	R: fxd: M/F 316K 1% ¼W	47:11:3163	1
R2	R: fxd: M/F 5.62K 1% ¼W	47:11:5621	1
R3, R30	R: fxd: M/F 3.01K 1% ¼W	47:11:3011	2
R4	R: fxd: M/F 20.0K 1% ¼W	47:11:2002	1
R5	R: fxd: M/F 1.0K 1% ¼W	47:11:1001	1
R6, R14	R: fxd: M/F 1.50K 1% ¼W	47:11:1501	2
R7, R12, R15, R19, R23, R25, R26, R32	R: fxd: Comp 33Ω 5% ½W	47:22:3305	8
R8, R13	R: fxd: M/F 1.21K 1% ¼W	47:11:1211	2
R9, R11	R: fxd: Comp 2.0K 5% ½W	47:22:2025	2
R10	R: fxd: M/F 2.94K 1% ¼W	47:11:2941	1
R16, R17	R: fxd: M/F 750Ω 1% ¼W	47:11:7500	2
R18	R: fxd: Comp 1K 5% ½W	47:22:1025	1
R20	R: fxd: M/F 10.0K 1% ¼W	47:11:1002	1
R21, R22	R: var: WW 5K 1W 15T	47:53:502C	2
R24	R: fxd: M/F 69.8K 1% ¼W	47:11:6982	1
R27, R28	R: fxd: M/F 3.16K 1% ¼W	47:11:3161	2
R29	R: fxd: M/F 5.90K 1% ¼W	47:11:5901	1
R31	R: fxd: Comp 20K 5% ½W	47:22:2035	1
	Ferrite Beads Inductors	18:15:0001	12

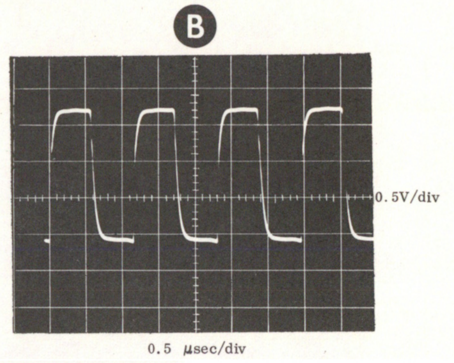
6236

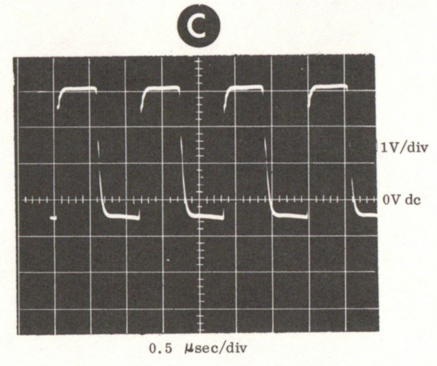


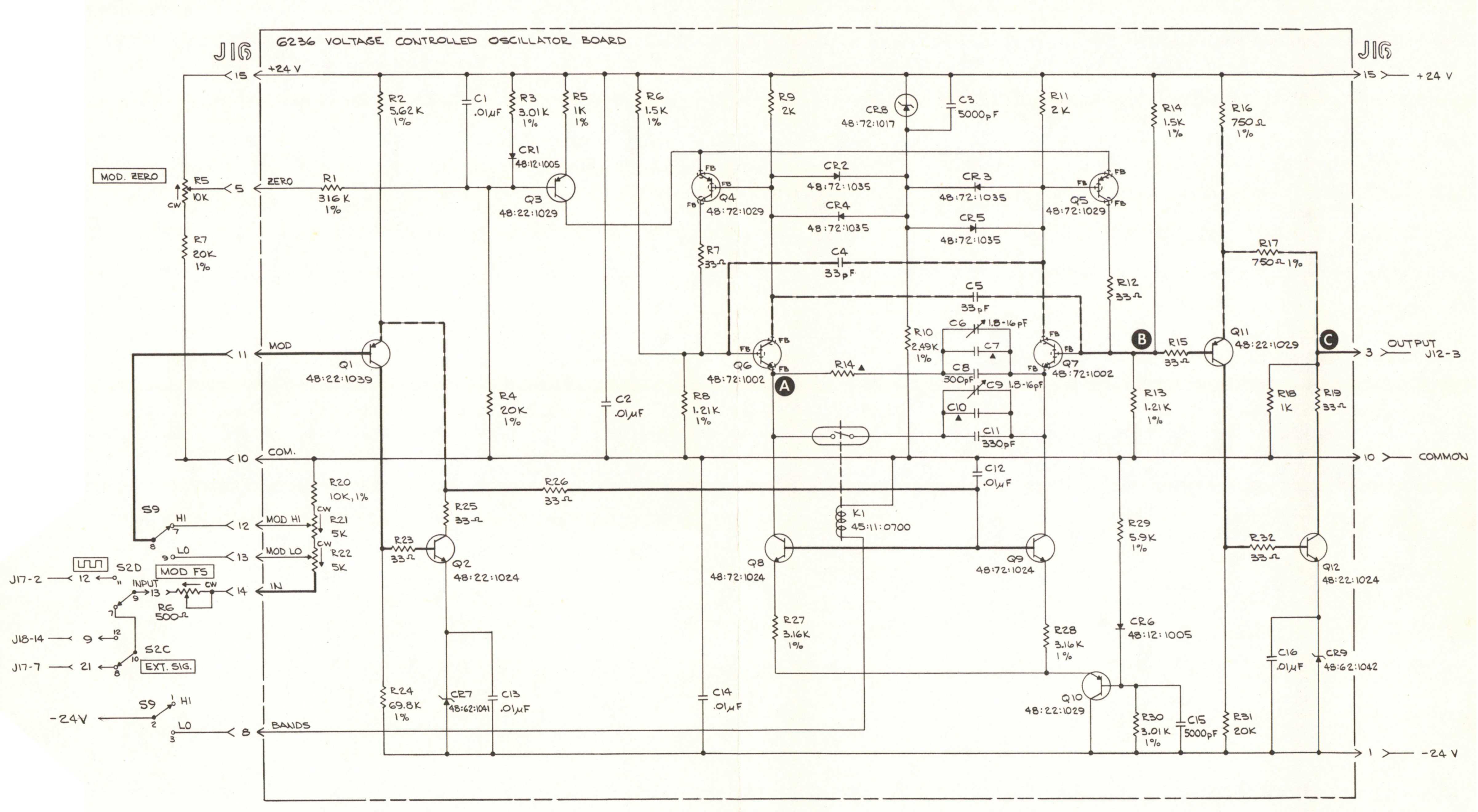
Test Conditions

DEV:0 FREQ. GROUP LOW









11. ━ ━ ━ INDICATES FEEDBACK PATH.
10. ━━━ INDICATES SIGNAL PATH.
9. ―< ←(SMALL SYMBOL) INDICATES 6252 PIN & SOCKET.
8. Q8 & Q9 MATCHED PAIR 48:72:1024.
7. Q6 & Q7 MATCHED PAIR 48:72:1002.
6. Q4 & Q5 MATCHED PAIR 48:72:1029.
5. CR4 & CR5 MATCHED PAIR 48:72:1035.
4. CR2 & CR3 MATCHED PAIR 48:72:1035.
3. FB INDICATES FERRITE BEAD.
2. ▲ COMPONENT SELECTED IN CALIBRATION.
1. ◯ INDICATES WAVEFORM PHOTO POINTS.
NOTES: